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TELEPHONE REPEATERS OR RELAYS.

The article by Mr. Lockwood on "Telephone Repeaters or Relays, and Repeating Systems," commenced in the issue of Nov. 14, and concluded in this issue of THE ELECTRICAL WORLD, gives the history of one of the most "fascinating" problems in the art of telephony. Inasmuch as the terms "relay" and "repeater" have been indiscriminately used when applied to telephony, there is, as Mr. Lockwood points out, little to differentiate the two. The principal distinction which he draws is that whereas a relay is locally applied to the receiving end for the purpose of reinforcing the main line current, the repeater is located between the transmitting and receiving stations for the purpose, not of producing increased loudness, but for operating a receiving telephone at greater than ordinary distances. Both conditions imply that some method is resorted to by means of which added energy is supplied to the receiving circuit, thereby excluding the ordinary induction coil so successfully used in meeting other requirements. The fact was early appreciated that a successful telephone repeater must be reciprocal in its action, so as to be adapted without the aid of other complicating mechanisms for the transmission of telephonic vibrations in either direction over an electric circuit. The comparatively small number of patents which have been taken out on telephone repeaters and the successful working of several of these types are facts which apparently indicate, even when considering that there are but few fundamental resources at the disposal of inventors for the introduction of new ideas, that the want of such instruments in the art is not pressing. The transmission of speech is rapidly increasing to longer and longer distances, until at the present time conversations between points 1500 miles apart are of daily occurrence, and experimental lines of 2000 miles in length have been successfully used on several occasions. These results have been brought about not by the introduction of radical changes in the systems employed, but by a gradual development along already existing lines, facts which warrant the belief that within a comparatively short period the overland transmission of speech from the Atlantic to the Pacific will be successfully achieved. Mr. Lockwood sees no future for the use of telephone repeaters over lines which may be operated by the direct method owing to the small possibility of their being effective and the necessary complications which their use is likely to introduce. The future of the telephone repeater, in Mr. Lockwood's opinion, lies in its use on branch circuits, where several receivers located at various distances from the main transmitting line are to be supplied. These views are apparently justified by past experience when it is considered that there already exist telephone repeaters which have given very successful results.

SYNCHRONOUS MOTORS AS COMPENSATORS.

The article by Mr. Ernst J. Berg, on the "Synchronous Motor as Compensator in Alternating-Current Distributions," commenced in the last issue of THE ELECTRICAL WORLD, demonstrates the advantages which may be derived by the use of synchronous motors for the purpose of increasing the power factor on the line, thereby increasing the available station output, the income derived from a given installation and the working efficiency of the entire system. The fact that an over-excited synchronous motor may take the place of a condenser on an alternating-current transmission, for the purpose of increasing the voltage at the receiving end of the line, has been known for several years and commented upon on various occasions in these columns. We believe, however, that Mr. Berg's article is the first treatment of the subject in a theoretical manner which leads to practical commercial results, and it

is for this reason that the various phases of the subject which the author discusses warrant the most careful consideration of managers of alternating-current systems. Mr. Berg considers four conditions: First, the most economical size of synchronous motor and the resulting saving brought about by its use when the line current is constant; second, the best capacity of synchronous motor to effect a gain represented by a reduced line loss when the receiving load is constant; third, to determine the best capacity of synchronous motor and the saving when the reduction of the line current will effect a saving in the cost of copper such as to warrant the installation of the motor, and fourth, the best capacity of synchronous motor when the saving in the cost of line copper and generator compensates for the installation of the motor. The result of investigating these propositions shows that the most economical size of synchronous motor corresponds with different power factors, and that for a power factor of 100 per cent. naturally no motor should be used, but as the power factor decreases the larger becomes the motor giving the highest efficiency. The most economical working condition is when the motor is of such size as to completely compensate for the idle line current, thereby giving a power factor of approximately 100 per cent. As pointed out by Mr. Berg, if a maximum working efficiency is to be obtained from a motor running at a given power factor, the motor current will need be decreased as the power factor increases, until such time as the power factor is about 100 per cent., which means that the receiving circuit has become non-inductive and that the motor takes practically no current. Operation on these lines at the same time results in the best regulation of the generator voltage. It follows also that if the saving in the cost of copper on the line is to pay for the motor, for comparatively short distance transmissions the motor should be installed only in the case of low power factors, while for long distances the use of a motor is warranted even for comparatively high power factors, owing to the fact that the cost of copper in the line forms a relatively large percentage of the total cost of the system. If the motor be employed partly as compensator and partly for the purpose of doing mechanical work, then a still greater saving is effected than when used for either purpose separately. This condition implies at least one advantage possessed by a synchronous motor over a condenser used for the same purpose.

OUR EXPORT TRADE—ELECTRICAL APPARATUS AND STEAM ENGINES.

English electrical engineering circles have lately been somewhat exercised over the decision of the managers of the Bristol Tramway Company, Bristol, England, to introduce American built engines in the extension of that company's power plant. In referring to the matter, some of our English contemporaries do not understand why it was necessary to go away from home for the new engines. The *Electrical Review* expresses the belief that it is due to the fact that English engineers, not having so much experience in electric railroading as Americans, are unable to build an engine that can compete in all essential points with the American types. English engines are acknowledged to be inferior in the matter of governing and in the lack of fly-wheel power, and the electric railway engineer naturally looks to America, where great experience has been had with machinery that will reliably meet the requirements of electric railway practice. The wail of our contemporaries might create the impression that this is the only instance where American engines have been selected for this class of service on English soil, but such is not the case. Several other English companies are operating American engines, many of which have been supplied on duplicate orders. Therefore the Bristol case has no particular significance except as an indication that American engines are growing in favor with English engineers, and that our export trade in this line is increasing. In this connection it will be interesting to consider the conditions of our export trade in engines and electrical machinery of various types. It may not be generally known that American machinery, both steam and electric, has met with much favor abroad, but owing to the practice of most manufacturers to conceal, for obvious reasons, the magnitude and character of their foreign trade by clearing their goods under a general classification, it is quite impossible to so classify the exports as to obtain even a fairly approximate estimate of the number and value of dynamos, engines, boilers and other apparatus exported. Personal inquiry among manufacturers, however, shows that the foreign trade is rapidly increasing, and the figures obtainable at the New York Custom House in a general way bear this out. In 1886, the value of exports under the general classification of machinery was $3,685,000; in 1890, $8,954,000, and in 1895, $11,493,000. Stationary steam engines are classified by themselves, and in 1886 their export value was $123,000; in 1890 it rose to $305,000; it fell off in 1891 to $217,000; in 1892 it increased to $227,000, was $254,000 in 1893, and surpassed the figures of 1890 in 1894 by attaining a value of $313,000. In the year 1895, however, owing to the commercial depression in trade, the figures dropped to $220,000. Judging from information obtainable through private channels, the present year will in all probability exceed the highest previous record. Instruments and apparatus for scientific purposes, including telegraph and telephone instruments, form a very large part of the export trade. In 1886, the value of such exports was $479,586; in 1891 it reached a value of $1,575,444, having steadily increased during the intervening years. In 1892 the exports fell off, but the losses were recovered in the subsequent years, and in 1895 the figures reached the value of $1,912,771. English manufacturers receive much practical aid through the Government consular service, which is an advantage not enjoyed by American manufacturers under the present American consular system. Perhaps it would not be advisable for American consuls to indulge in trade jobbing to the same extent as that carried on by the British consuls, but we believe that our present consular system would be more effectual if the offices savored less of political plums distributed as payment for party services. It is not our intention to discredit the effective work which the present consular reports render to American trade, but this does not offset the belief that the service could be materially improved. American manufacturers have lately taken upon themselves to carry on more effectively the export trade, by organizing a national association for the promotion of foreign trade, the machinery of which is already in motion with beneficial results. In summing up the situation, the question naturally arises: What are the conditions which render it possible for American manufacturers to compete with foreigners on their own ground? Is it because American goods are cheaper or is it because they are superior? In reply to this question one of our prominent manufacturers of machinery said that his company could not compete with England in the lower grades of products, but in the higher first-class grades England could not meet the American competition. This same explanation was given by other concerns, from which it is therefore evident that the influence tending to widen the foreign trade channels for American manufacturers is the general excellence and serviceability of our products rather than their price. We are informed from reliable sources, however, that American machinery has on many occasions been sold on the Continent of Europe at a price under that bid by resident firms. Americans are never satisfied with what they have, but always strive to attain something better. The result of this spirit is exemplified in many ways, and as regards machinery it is shown in the apparent improvements and constant tendency toward higher efficiency. It is this that makes the American products so desirable, and as one gentleman stated, "That is just where Uncle Sam gets in his good work."

The Determination of the Quality of a Vacuum by Electrostatic Discharge.

BY CONVERSE D. MARSH.

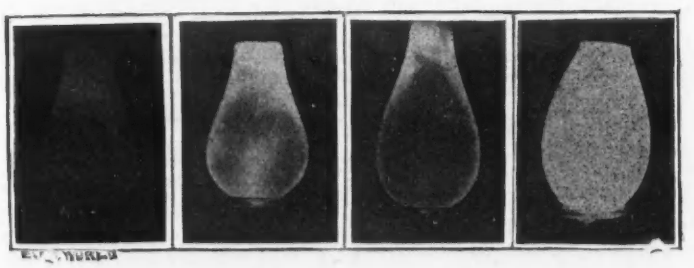
The prominent makers of incandescent lamps usually subject their product to a test on an induction coil, in order that those lamps which have an inferior vacuum may be rejected. The common method is to connect one terminal of the coil to the base of the lamp in electrical contact with the filament connections, and the other simply surrounds the top of the lamp, being often in the form of a metallic cap. The coil is then allowed to discharge across a spark gap, and the lamp will glow to a greater or lesser degree, according to the quality of its vacuum. The discharge gap is used for the reason that if the coil was allowed to expend its whole E. M. F. upon the lamp itself the filament would be attracted to the sides of the globe or threshed about by the discharge in a manner to seriously weaken or break it.

A short time ago the writer decided to have made a series of tests of the lamps on the American market, subjecting them to the full coil potential, regardless of whether the filament was fractured or not, the idea being to determine the quality of the vacuum. To a certain extent the results of such a test are somewhat deceptive. A single lamp of a set may glow more than its mates, not because its vacuum is more imperfect, but because it is adjusted to a better condition of electrical resonance, and therefore glows more brightly. Similarly the photographic records, which are herewith submitted, are somewhat misleading, due to the fact that the light from the lamps in some cases was less actinic than in others, although to the eye the amount of glow appeared the same, while the record on the photographic plate shows somewhat different results. While the difference is marked, however, the results are comparative, for these causes just recited only produce minor differences in the intensity of the glow when a small coil having three-quarters of an inch spark is employed. Besides the actual intensity of the glow in the lamp there are other and very important features in the appearance of the nebulæ, and these points have been faithfully brought out in the photographic record.

These fluorescent effects may be divided into five different classes.

The first class is that of a practically perfect vacuum, which, on an induction coil, capable of passing a one half to three fourths inch spark, usually gives a sudden burst of fluorescence, and then subsides in a darkness until the coil is stopped, when the lamp discharges with a fluorescent flash. The movement of the filament on the inside of the globe in such a lamp always causes the latter to fluoresce brilliantly, but in these tests it was endeavored to choose a length of spark that did not seriously disturb the filament, and cause this result to be brought about.

The second class consists of those lamps in which a faint cloud appears on the inner surface of the glass, flickering or fluorescent in its character, and of a light, fleecy appearance.



FIGS. 1, 2, 3 AND 4.

The third class consists of the same fleecy clouds, and in addition, a glowing halo of light, which seems to fill the entire bulb.

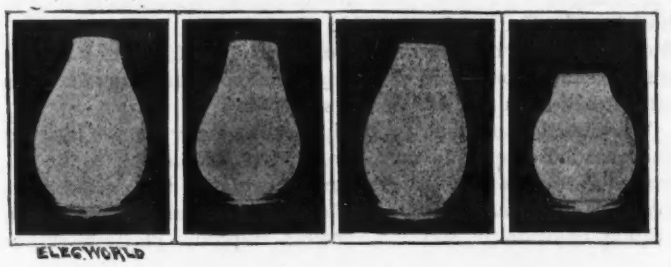
The fourth class consists of a still more strongly defined light of a whiter character. In this class the filament can quite often be faintly seen as a glowing thread of light.

In the fifth class the filament is very strongly defined, and purple streamers fill the entire globe, showing the presence of nitrogen gas, from which it may be inferred that a proportionate amount of oxygen is also present, and though the latter gas does not fluoresce as brilliantly, it means the speedy death of the filament.

The method of photographing, in detail, was as follows :

An induction coil capable of giving a suitable spark was connected to the cap of the lamp, and the other terminal of the induction coil was placed in a jar of water, in which the tip of the lamp and a portion of the bulb rested. By choosing a suitable condenser on the coil, a point was reached where maximum fluorescence of all the lamps was obtained.

The first condition described is shown in Fig. 1. This lamp had a vacuum so perfect that under the ordinary half-minute exposures on the induction coil, which was given to the other lamps, only a slight trace could be found upon the plate, so slight, in fact, that it would be lost in half-tone reproduction. In order to bring out the nature of the fluorescence, however, the lamp was put on a Wimshurst machine, capable of giving more power, and exposed for one minute, double the time of the other lamps. The negative was then intensified, and the results, it will be seen, are faintly visible. Such luminous effects as exist cling closely to the sides of the globe, and the filament is in no way visible. Certain bright spots at the base of the lamp were due, not to fluorescent effects within it, but to a brush discharge from the brass cap outside.



FIGS. 5, 6, 7 AND 8.

The second class is well illustrated by Fig. 2, in which the nebulous clouds described seem to concentrate near the brass cap. This, however, is due to the condenser effect of the cap, for there is no reason why large volumes of luminous gases should be concentrated in either end of the lamp. As we shall presently see, however, there can be local streams of gas from the filament, and from the "clamps" or joints, but there can be no large body of gas in any one part of the globe, as this photograph might, at first sight, lead the observer to believe.

Fig. 3 illustrates a lamp which might be said to be between classes 2 and 3, although the photographic record does not show any notable difference between the two. As a matter of fact, however, the light was of a more steady character.

Fig. 4 illustrates a lamp which would come under class 4, in which the white light is much stronger and steadier, and the filament has a slight definition. There are also streaks of purple discharge to an extent that would almost place the lamp in class 5.

Fig. 5, while apparently a very luminous lamp, would come under class 3, for the reason that the filament is not defined, except as a black mark, and the fluorescence is not streaked with purple. It is, however, a strongly-developed specimen of this class.

Fig. 6 was the only European lamp examined, and would be an extremely poor No. 3. The filament was slightly defined but, due to the general fluorescence throughout the globe, it was lost in the photograph. This lamp gave more actual light than any other, although it had not nearly so poor a vacuum as those which are to follow.

Figs. 7 and 8 illustrate lamps which are in class No. 5 ; the worst possible condition to be observed, where a partial vacuum has been obtained.

In Fig. 8 it will be noted that the filament is very strongly defined, and, although it does not show in the photograph, the lamp was full of a purple-streaked discharge, indicating the presence of nitrogen gas from the original air the lamp contained. The reason of this strong definition of the filament lies in the fact that the air was either pumped out too rapidly or the filament insufficiently flashed during this operation or a combination of these factors.

These little streams of escaping gas will always glow very brightly, giving the filament the appearance of a wire carrying a static charge in a darkened room. Those who have experimented with lamps will recognize this phenomenon as similar to that which a punctured lamp exhibits when a stream of air entering the globe produces a purple light, which often will continue after the electrical excitation has been removed. It is probable that if the clamps or joints of these lamps were examined that they would be full of miniature volcanic craters, where gas was or had been escaping, thereby injuring the filament and causing its service to be covered with a sooty deposit. This results in a diminished candle-power at the rated voltage and in a lamp having an efficiency under four watts per candle greatly

reduced life. It can be generally stated, however, that in poor economy lamps a high vacuum is not so essential as in lamps rated at an efficiency of from 2.5 to 3.5 watts per candle.

The results seem to justify the conclusion that American makers, as a whole, should be much more careful in the exhaustion of their lamps and in the elimination of poor lamps subjected to stringent tests. Until this is done, it may be expected that there will be much denial of the possibility of manufacturing lamps having an efficiency under 3 watts per candle or even under 3.5 watts per candle properly rated by reliable standards. Such higher efficiencies are largely dependent upon filaments of great density, uniform in size, of light colored and smooth texture.

Becquerel Rays.

BY A. F. MCKISSICK.

Some time ago Becquerel discovered that certain uranium compounds emitted, after exposure to sunlight, radiations which, like the Röntgen rays, could pass through plates of aluminum or of cardboard, and effect a photographic plate behind, and also that this radiation could be polarized or refracted. He found that the potassium platinum compound of uranium emitted these rays for 15 days, after it had been first exposed to sunlight.

It occurred to me that probably a great many of the fluorescent and phosphorescent substances would give radiations of this kind, and with this idea I tried all such substances that are known as available, and found that the following gave these radiations, *viz.*: lithium chloride in solution, barium sulphide, calcium sulphate, quinine chloride, quinine sulphate, calcium nitrate, sugar, chalk, glucose, sodium tungstate, sterein, uranium acetate and ammonium phospho-molybdate.

In making the experiment, the articles to be photographed were placed in contact with the sensitive plate in the plate holder, the cover put on and the substance, after an exposure to direct sunlight for two hours, sprinkled over the cover of the plate holder. The plate holder was then carefully covered with a dark cloth to prevent light from reaching it.

The time of exposure necessary to give a clear photograph was found to be from 48 to 72 hours, varying with different substances. A slow plate (sensitometer No. 16) was used with ordinary developer and fixing bath.

The negatives obtained were rather weak, but showed clearly that the light was very much like the Röntgen rays, inasmuch as both glass and metal were opaque to the light, while cardboard and wood were transparent.

A very peculiar property noticed was that generally more than one image of an object was produced although the object was in direct contact with the sensitive plate. In one negative there are four images of one half dollar, in another two images of a key, the images being at right angles to each other. One of the images was always much clearer than the others. I have noticed on several negatives two images of an object near one edge of the negative and near the opposite edge only one image of an object, so that this action, whatever it is, was not uniform.

Of all the substances tried I found granulated sugar to be the best. I have succeeded in taking a fairly clear negative through 2½ inches of wood with sugar.

Prof. B. B. Ross suggested that inasmuch as quite a number of fluorescent and phosphorescent substances possessed high molecular weights, other substances of high molecular weight, although not previously known to be either fluorescent or phosphorescent, might give off these rays. With this idea sterein and ammonium-phospho-molybdate, were tried. The first, sterein, darkened the sensitive plate only slightly, but the last one, ammonium-phospho-molybdate, gave a fairly good negative, on which were observed two images of one object.

Uranium nitrate, sprinkled on top of the plate holder containing the sensitive plate and then exposed to sunlight for 18 hours, gave only a faint negative.

Tests of a 150-kw Turbo-Alternator.

In a test made on a 150-kw Parsons turbo-alternator Mr. W. D. Hunter shows results which indicate a considerable steam economy with a compound steam turbine under ordinary conditions. According to our contemporary, the London *Electrical Review*, the plant consisted of a compound steam turbine of the Parsons latest improved type geared in the ratio of 2 to 1 by helical spur gearing to a standard type of Parsons 150-kw alternator and direct-coupled exciter, the speed of the motor being 9400 revolutions per minute, and that of the alternator and exciter 4700 revolutions per minute, the steam pressure at the steam chest of the motor was 70 pounds, and the vacuum 26⅛ to 26¾ inches, neither being favorable to best economy. The steam consumption was measured by carefully calibrated feed tanks, and the electrical output by a Kelvin wattmeter, cross-checked by an independent ammeter and voltmeter. No steam separator was used. The power was absorbed by a water resistance. The accompanying table gives the results of the tests:

Test of 150-kw Turbo-Alternator.

Units.	Vacuum at Cylinder.	Total Water per Hour, Lbs.	Water per Unit. Lbs. per Hour.	Water per E. H. P. Lbs. per Hour.	Revs. per Min.	Remarks.
150.33	26⅛	3484	23.17	17.28	4700	Barometer 29.3. Pressure of steam 70 lbs. per sq. in.
72.84	26⅛	1950	26.77	20.00	4700	
38.97	26⅜	1150	29.51	22 01	4700	
.175	26¾	437	.....	.....	4600	

System of Electric Traction with Monophase Alternating Current.

BY RICCARDO ARNO.

In this system of electric traction, devised by Prof. Galileo Ferraris and the author, a low tension monophase alternating current, generated either direct by means of a low tension alternating current machine or by means of ordinary alternating current transformers located upon high tension conductors, passes through one single insulated overhead or underground conductor A, and one non-insulated conductor B, inserted in the ground and connected with the rails, or the rails alone acting as such conductor. The system is therefore practically upon the same lines as the ordinary continuous current systems of electric traction now commonly used.

This system of electric traction with monophase alternating current is based upon the use of phase-displacing transformers T, consisting of two coils, one primary S_1 and one secondary S_2, which are placed perpendicular to one another, and which have conveniently different numbers of windings, so that the voltage of the primary and secondary currents shall be the same in the two coils, and of a short circuited armature K, which is maintained in rotation by the monophase alternating-current in the primary coil.

In this explanation of the system we have supposed for simplicity and clearness that the phase-displacing transformer T is of the

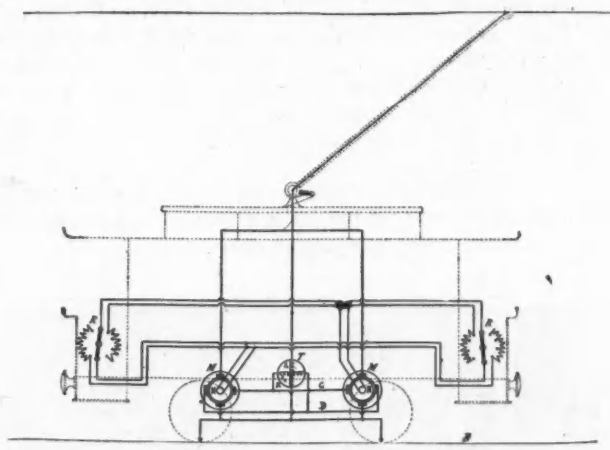


Diagram of Car-Wiring Circuits.

bipolar type, in which case the primary and secondary coils S_1 and S_2 are perpendicular to one another. It is not necessary to say that in practice the phase-displacing-transformer T may be of the multipolar type, in which case the primary and secondary coils are disposed as two sets of coils in a two-phase motor.

The electric motor or motors M, which drive the train, are of the a synchronous two-phase type and are actuated by the alternating-current from the conductors A B and by another phase-displaced current from the conductors C D, generated by a phase-displacing-transformer T, fed by the monophase current and carried upon the car or on one of the cars belonging to the train.

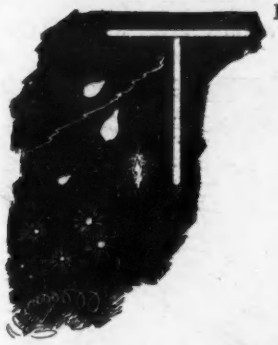
Consequently we obtain, in correspondence with each car or each system of cars forming a train, a two-phase system A B C D, with which the two-phase electric motor or motors M, for driving the car or train, are fed.

Thus the motors will not only be started under a charge, but will also be capable of attaining any desired speed, by the variation of a resistance R inserted in the circuit of their armature H.

Niagara Power Transmission Up to Date—II.

CATARACT POWER FOR STREET RAILWAYS IN WESTERN NEW YORK.

BY FRANK C. PERKINS.



THE power from the great cataract is now operating nearly all of the street railway lines in Western New York between Buffalo and Niagara Falls, and will no doubt soon extend its range to suburban lines of even greater distance.

THE POWER HOUSE.

There are now in operation at the Niagara Power Company's plant three rotary transformers for street railway work. The current is supplied to these machines from the 5000-hp two-phase generators.

The rotary transformers and static transformers reduce the alternating two-phase current of 2000 volts to a direct current of 575 volts, that it may then be used directly by the street railway motors upon the various lines. The heavy copper connections on the back of the switchboard, shown in one of the illustrations, give some idea of the heavy currents to be carried.

The rotaries are started by means of a small quarter-phase motor used for this purpose alone, and connected directly to the shaft of the large machine. When the small motor has the large armature up to speed, then the field of the main armature is closed and the voltage gradually rises to the maximum. Two incandescent lamps are used to tell when the armatures have reached the proper speed. These two synchronizing lamps are in series with the secondaries of the two 2000 to 100 volt transformers, the primaries of which are attached to the main dynamo circuit and large static transformer. When the lamps indicate that the speed is proper the switches are thrown and the rotaries are then performing their regular work of transforming the alternating current at 440 volts to a direct current of 575 volts, the voltage being raised in a ratio of about 7 to 10. The rotary transformers were built two by the Westinghouse Electric Manufacturing Company and one by the General Electric Company; each machine has a capacity of about 500 kilowatts. They are operated two at a time, one being kept in reserve for emergencies and for changing machines; also one to rest part of the time. The conductors are carried under the floor to the back of the

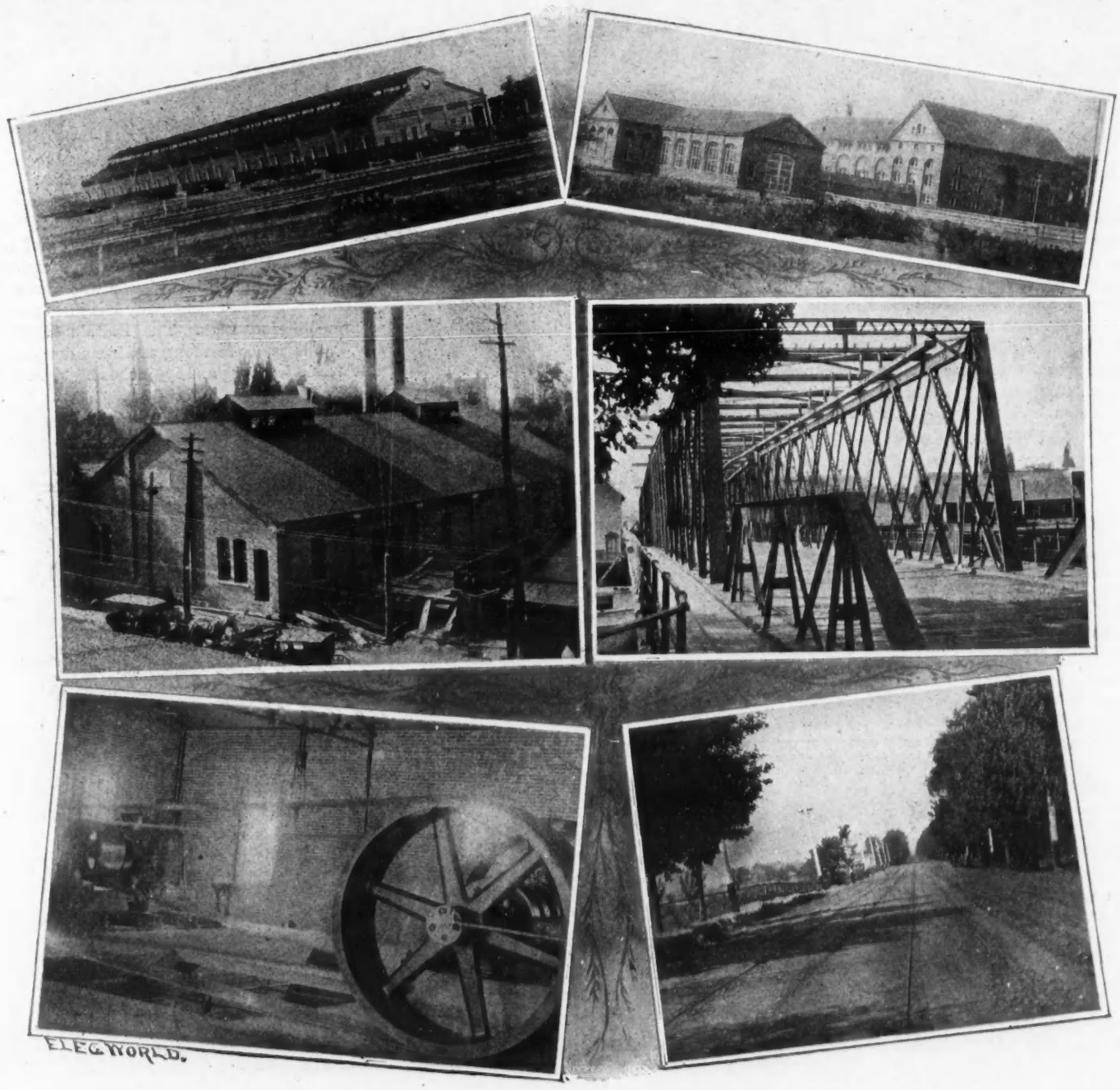


FIG. 1.—TONAWANDA CAR BARNS AND BUFFALO & NIAGARA FALLS LINE.

FIG. 2.—BUFFALO & NIAGARA FALLS POWER HOUSE.

FIG. 3.—STEAM POWER PLANT REPLACED BY NIAGARA POWER.

FIG. 4.—TRANSFORMER HOUSE, CONDUCTOR BRIDGE AND CATARACT POWER HOUSE.

FIG. 5.—TONAWANDA BRIDGE, BUFFALO & NIAGARA FALLS TROLLEY LINE.

FIG. 6.—BUFFALO & NIAGARA FALLS TROLLEY LINE.

direct-current switchboard shown in the illustration. Six switches on the street railway direct-current switchboard control the current for the main street line, the Sugar & Pine Street line, and the Buffalo & Niagara Falls street line, also the Whirlpool Rapids line. The current used is indicated by Weston ammeters reading to 1000 amperes each. Other switches control various motor circuits. One motor at the water-works operates at a pump on a 500-volt circuit. One switch controls a line delivering current to a 500-volt motor at Dobie & Stewart's.

One double switch controls the line which furnishes current for heating the building by electricity, about 200 horse-power being used for this purpose on a 500-volt line.

One rotary transformer of 100-kw capacity transforms alternating current from one of the large generators from 2000 volts to 220 volts direct current. This machine runs the electric crane and two electric motors of 15 horse-power each for opening and closing the gates.

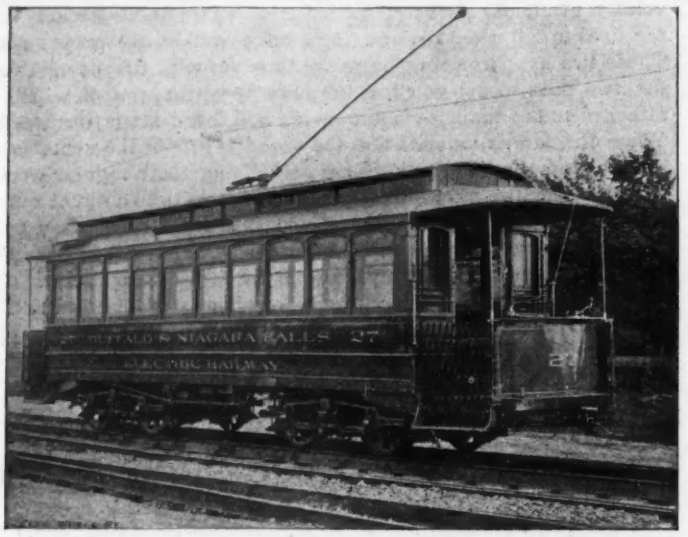


Fig. 7.—Four Motor Trolley Car Operated by Niagara Current.

Fig. 8.—Interior Buffalo & Niagara Falls Car.

current from the main bus-bars to the transformers. As the system is two-phase four cables are required, two for each phase. These cables are connected to double throw switches upon the switchboard.

BUFFALO & NIAGARA FALLS STREET RAILWAY.

The officers of the Buffalo & Niagara Falls Street Railway Company, when organized, were Hon. W. Caryl Ely, president; B. Van Horn, general manager, and Geo. H. Dunbar, secretary and treasurer. The company was bonded for $750,000 and had a capital of $1,250,000. The contract for the entire installation was awarded to the White-Crosby Company. The same company has just furnished the Buffalo-Niagara Transmission Line. The Buffalo & Niagara Falls Electric Railway line is 75,000 feet long and has a double track throughout. The rails are 60 feet long and 6⅞ inches high, weighing 78 pounds per yard.

POWER-STATION.

The power-house is located at North Tonawanda. The engine room is 50 x 60 feet and is equipped with two Ball cross-compound engines of 250 horse-power each. These engines are 13 x 16 and 22 x 16 cylinder dimensions and are belted to two 200-kw multipolar

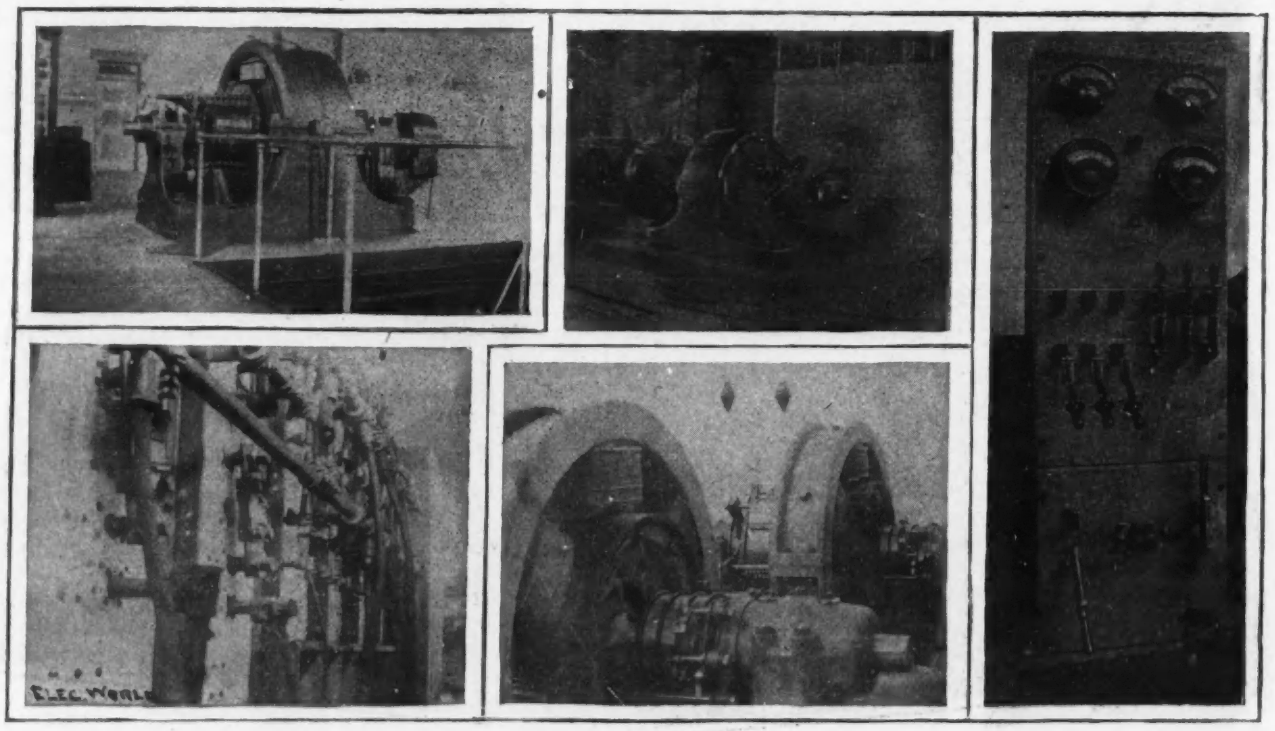


Fig. 9.—Street Railway Rotary Transformer, Cataract Power House.

Fig. 10.—Rear Connections of Switchboard at Niagara Falls.

Fig. 11.—220-Volt Rotary Transformers.

Fig. 12.—Rotary Transformers, Buffalo Power House.

Fig. 13.—Switchboard for Rotary Transformers, Buffalo Street Railway Power House.

THE CONDUCTORS.

The large 5000-hp generators furnish current to the main bus-bars at 2250 volts potential. There are four cables which conduct the

General Electric Railway generators. In the boiler-house are installed four return tubular boilers of 150 horse-power each. The boiler-house is 45 x 60 feet. The plant may be run non-condensing or condensing. The current is now supplied from cataract power house. The car barn is located at La Salle and is built of brick and steel. The structure is 370 feet long and 72 feet wide. The offices are in this building, and the entire structure and equipment is up to date.

THE NIAGARA FALLS RAILWAY.

The current for the Main Street line, the Sugar and Pine Street line and Whirlpool Rapids line, is conducted to the feeder from the rotary transformers of the Niagara Falls Power Company. The Niagara Falls Railway has a number of miles of single and double track. Twenty-three pound 7-inch Cambria rails, and 60 and 60½ pound 7-inch Johnson rails are used in the construction. Side pole construction is used mostly in this installation. The overhead apparatus is of General Electric construction. The engine equipment in the steam power-house consists of three Ball engines belted to three 200-kw General Electric railway generators. The current for the Niagara Falls Railway is now generated at the power-house of the Niagara Falls Power Company, and conducted to the feeder cables from the rotary transformer switchboard.

BUFFALO ELECTRIC RAILWAY COMPANY.

The operation of the Buffalo Street Railway Company's plant by this current is the test of the complete success of the enterprise that dates its birth from the incorporation of the Niagara Power Company in 1886. The Railway Company takes 1000 horse-power at $36 per horse-power per annum. At one minute after 12 o'clock Monday morning, Nov. 16, Manager Chas. R. Huntley, of the Buffalo General Electric Company and Cataract Power & Conduit Company, waiting, watch in hand, said sharply: "Time!" As the word was spoken, W. S. R. Emmett, engineer in charge for the General Electric Company, standing by a slate switchboard near him, closed with a quick movement three heavy knife-blade switches and the rotary transformers rapidly reached full speed. The alternating ammeters reading 700 amperes on the start and in a few seconds dropping

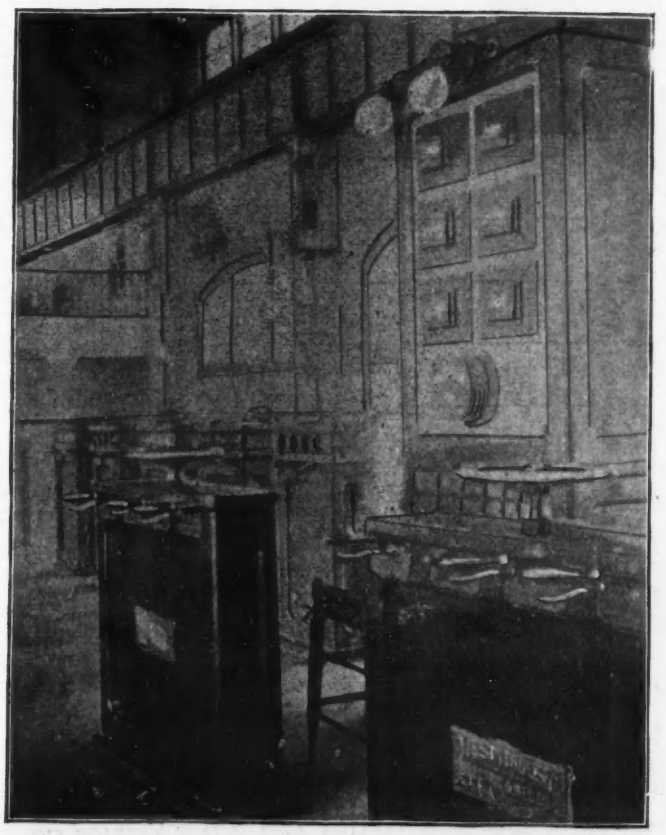


FIG. 14.—ROTARY TRANSFORMER CONTROLLER IN CATARACT POWER HOUSE.

back to 375 amperes. There was a quick breath caught by the intensely interested group of onlookers. There was a round of cheers, and Mayor Jewett, who stood near Manager Huntley, said impressively: "The power is here." It was an anxious moment for President Henry M. Watson, of the Buffalo Railway Company, who was early on the ground, and for Hardin H. Littell, vice-president and general manager of the road.

The moment the machinery started a signal was given to the man anxiously waiting at the door, and a few seconds later the thunder of a cannon fired by the Ninth Ward Polish-American Gun Squad woke the echoes along the Niagara River. A national salute of 21

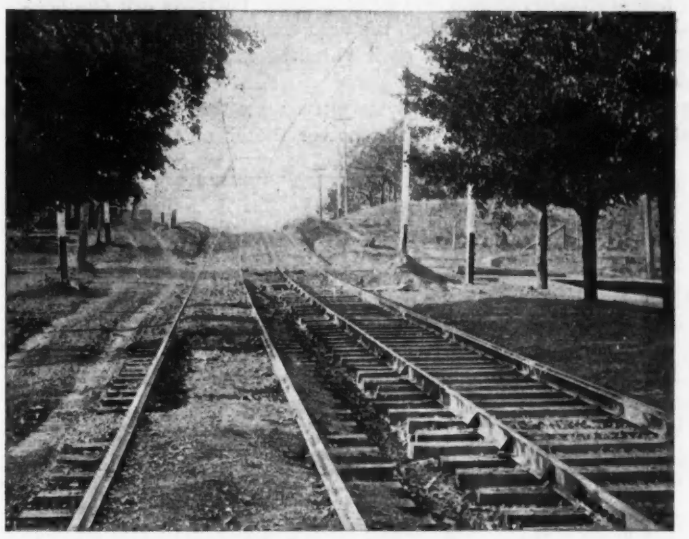


FIG. 15.—SECTION OF TRACK, BUFFALO & NIAGARA FALLS TROLLEY LINE.

guns was fired in token of the wide significance of the event heralded.

THE CONSTRUCTION OF THE LINE OF TRANSMISSION.

On Aug. 14 last a gang of 200 men started out from Niagara Falls to begin the work of setting the poles for the transmission of the Niagara Falls electric power to the City of Buffalo.

The work of constructing the line was necessarily slow and required considerable patience and skill. Many difficulties had to be encountered and overcome. The poles upon which the lines are strung from Niagara Falls to the city line are white cedar and range from 35 feet to 65 feet in length, according to the locality in which they are set. They were distributed at Niagara Falls, North Tonawanda, La Salle, and for a considerable part of the distance were distributed by canal boats.

Starting at the transformer building, located at the great Niagara Falls power building at the Falls, the line which brings the power to Buffalo takes the following course:

"Northerly side of Adams Avenue on the power company's property to a point 1½ miles east of Sugar Street, where it leaves Adams Avenue and runs along the west side of the Niagara Junction Railway to a point 500 feet from the Mile Line Road, where it turns at right angles and runs nearly east through the power company's land and through farm lands to a point one mile north of La Salle. From this point it runs along the old Mile Line survey to Tonawanda Creek. It crosses Tonawanda Creek near Division Street in Tonawanda and then passes southerly across the lands of the Buffalo Thousand Islands & Portland Railway to Ellicott Creek. Then it continues south to the southerly line of the village of Tonawanda. From this point it runs west for a mile and a quarter, where it strikes the east bank of the Erie Canal near Hinds Street in the village of Tonawanda. From this point the line extends along the banks of the canal all the way to Buffalo. At a point about 300 feet north of Brace Street in Buffalo the poles and wires disappear."

There the cables are put underground and run in conduits for a distance of 4200 feet to the Buffalo railway power-house on Niagara Street. The line runs for 18 miles through private property, a right of way having been secured by the Niagara Falls Power Company. About three miles of line are within the city limits of Buffalo. Five miles are along the banks of the Erie Canal, the right of way having been secured some time ago. If the time should ever come when the electric power is used for propelling canal boats it will be a great saving of expense to have the line so close to the canal. Many points contemplating the future use of the power were taken into consideration in locating the line.

Synchronous Motor as Compensator in Alternating-Current Distributions.

BY ERNST J. BERG.

(*Continued from page 624.*)

It is of considerable interest to compare the efficiency of the plant at different loads with and without the synchronous motor. In Fig. 8 are given some curves, giving the efficiency at any load, as the load was originally, as it is when the lagging currents are compensated for at any load, and when the field excitation of the synchronous motor is kept constant at such value as is most economical at full load.

In calculating the first of these curves we have assumed the resistance of the line to be .52, the power factor of the load 65 per

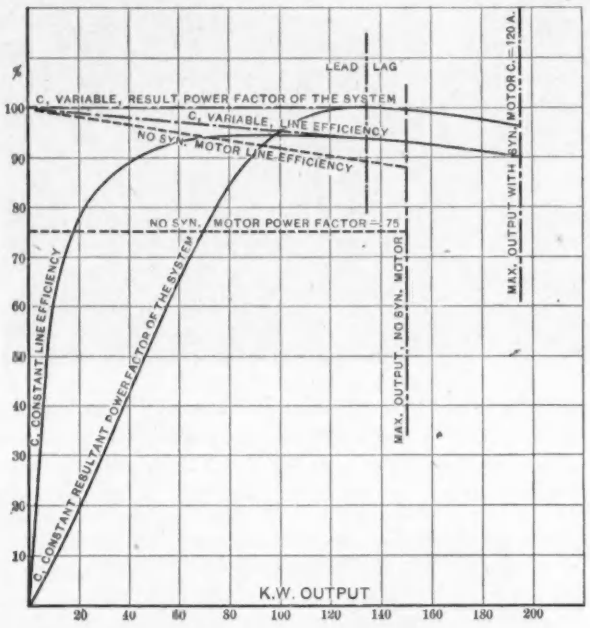


Fig. 8.—Efficiency and Power Factor Without and With Compensation by Synchronous Motor.

cent. at all loads. Usually, however, the power factor of a system changes considerably with the load being highest at heaviest load and lowest at the lightest loads.

It is seen that at the maximum output the efficiency is 88 per cent. when no synchronous motor is used and that this maximum output point corresponds to 150 kilowatts.

With the most economical synchronous motor running with the most suitable field excitation the maximum output is 196 kilowatts and the efficiency is then 90 per cent. At the same load as the maximum load before compensation the efficiency is 93 per cent. instead of 88 per cent.

If the field excitation of the synchronous motor is left constant the efficiency of the system is naturally low at light loads, since we then are running with large wattless leading currents. As seen in the same figure, the efficiency with a 50-kw load is then only 92 per cent. as compared with 96 per cent. when the synchronous motor is not running. Changing, however, the field excitation we can bring the efficiency up still higher as seen.

The effect of the synchronous motor on the power factor of the system is noticeable and can of course be anything desired when the field excitation is varied, the most economical being when all lagging currents are compensated for when the power factor is 100 per cent.

Running the synchronous motor with constant field excitation, the power factor is lower than 75 per cent. up to 70-kw output, and higher for larger outputs. It reaches 100 per cent. at 134-kw output, and is 96 per cent. at maximum output.

II. THE RECEIVING CIRCUIT SUPPLIED WITH CONSTANT POWER, THAT IS, $c \cos\phi$ = CONSTANT.

In this case the current in the line will vary with the phase relations of the receiver circuit, consequently, although the phase relation of the E. M. F. consumed by the impedance of the line is the same for all currents, the magnitude of this E. M. F. varies with the current.

Let c be the constant energy current at the end of the line, $\frac{c}{\cos\phi}$ the total current, and $c \tan\phi$ the wattless current.

Substituting for c in equation A we have E_0, the generator voltage, equal to

$$\frac{1}{\cos\phi}\sqrt{c^2 u^2 + E^2\cos^2\phi + 2 u E c \cos(\omega^2 - \phi)\cos\phi} \quad (D),$$

where ϕ is positive for lagging currents and negative for leading currents.

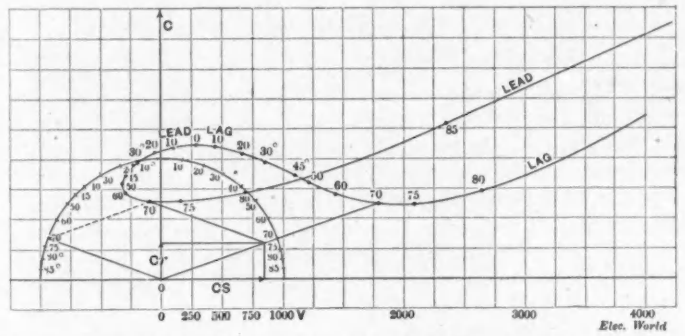


Fig. 9.—Generator Voltage at Constant Power and Constant Voltage at Receiving End, But Variable Power Factor of Load.

Fig. 9 gives the locus for the generator voltage when the receiving end voltage is constant.

In our example

$$c = 200 \text{ amp.}$$
$$E = 1000 \text{ volts}$$
$$r = .52 \text{ ohms}$$
$$s = 1.45 \text{ ohms}$$
$$\tan\omega = \frac{1.45}{.52} = 2.79, \quad \therefore \omega = 70°$$

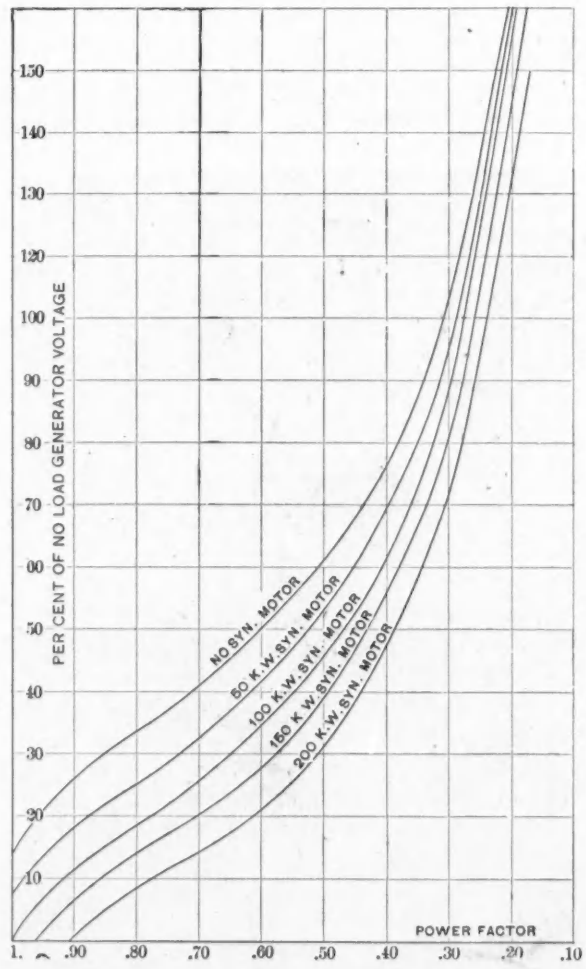


Fig. 10.—Compounding of Generator at Contact Voltage and Power in Receiving Circuit, but Varying Power Factor, Without and with Synchronous Motor.

For $\phi = 70°$, that is, 70° lag in the receiving circuit or with a power factor of about 34 per cent.

$$\omega - \phi = o, \text{ and } E_0 = \frac{1}{\cos\phi}(E\cos\phi - c\,u) = E + \frac{c\,u}{\cos\phi}$$

or the drop in the line is the same as the impedance drop.

E_0 = minimum.

$$E_0 = \sqrt{\frac{c^2 u^2}{\cos^2\phi} + E^2 + 2 u E c \frac{\cos(\tilde{\omega} - \phi)}{\cos\phi}}$$

that is, $\frac{c^2 u^2}{\cos^2\phi} + 2 c u E \cos\frac{(\tilde{\omega} - \phi)}{\cos\phi}$ a minimum,

or $\tan\phi = -\frac{E \sin\tilde{\omega}}{c u}$.

In this particular example

$$E = 1000.$$
$$\tilde{\omega} = 70°.$$
$$c = 200.$$
$$u = 1.54.$$

Thus $\tan\phi = -3.05$ or $\phi = -70°$ lead.

Thus the minimum-generator voltage is gotten when the power factor is — 34 per cent., that is, 34 per cent. and the current in the receiving circuit is leading the E. M. F.

In Fig. 10, which is calculated with same constants as above, is given the compounding, that is, the constant by which the terminal voltage has to be multiplied to give the generator E. M. F. without compensation and with different capacities of the synchronous motor.

With a non-inductive receiver circuit the compounding is 1.14; that is, the generator voltage is 14 per cent. higher than the voltage at the receiving end. With a power factor of 88 per cent. the compounding is doubled and is tripled with a 70 per cent. power factor. With very low power-factors, for instance 50 per cent., the compounding is 61 per cent., or over four times the non-inductive load compounding.

A power factor of 50 per cent. may occur in a commercial plant, if, for instance, its load consists of small induction motors running practically light. However, modern induction motors have been employed at 1/10 load, giving a power factor between 60 per cent. and 70 per cent., so that hardly any plant should go as low as 50 per cent.

A 50-kw synchronous motor running as compensator will materially help the compounding. Fig. 10 shows that with a 70 per cent. power factor the compounding is only 34 per cent., as compared with 42 per cent. without the synchronous motor. With a non-inductive receiving circuit the compounding is 8 per cent., as compared with 14 per cent. without the motor.

The larger the synchronous motor the lower is the compounding at all loads. It becomes negative with a non-inductive load with a 100-kw motor. A 200-kw synchronous motor gives the same compounding with 70 per cent. power factor of the load as the compounding of the generator at the same non-inductive load.

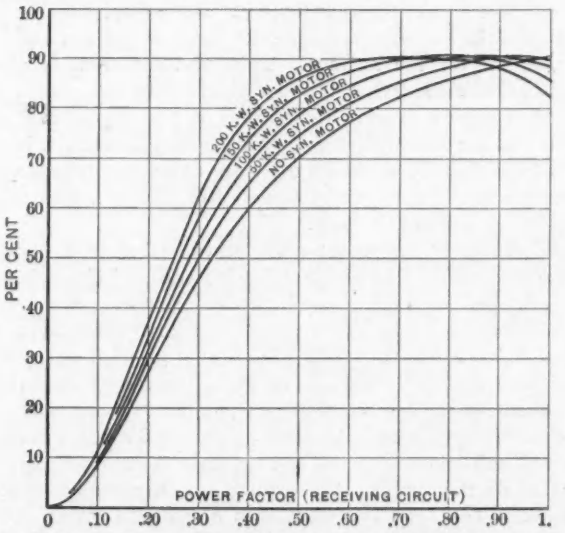


FIG. 11.—EFFICIENCY, WITHOUT AND WITH COMPENSATION BY SYNCHRONOUS MOTOR.

The efficiency of the system is largely dependent upon the power factor; that is, upon the more or less complete compensation of the idle currents in the line.

In Fig. 11 is given the efficiencies of a plant with the same constants as have been used throughout; the maximum efficiency occurs naturally when the load is non-inductive; it is then 91 per cent. Due to the increased $c^2 r$ loss in the line on account of increased current with decreased power factor the efficiency drops quickly, and is for instance only 84 per cent. with a power factor of 75 per cent.

Fig. 10 shows also how the size of a synchronous motor increases with decrease of the power factor; if maximum efficiency is desired further, if a synchronous motor is intended for maximum efficiency at a load of a certain power factor, the capacity of the synchronous motor, that is, its current, has to be decreased with increasing power factor of the load.

So, for instance, if we had at our disposition a synchronous motor of maximum capacity of 200 amperes, it would be desirable to use this as compensator at its full current capacity for loads from 0 per cent. power factor, to 70 per cent. power factor, then gradually reduce the current (by reducing the field excitation) so that at about 80 per cent. power factor of the load the most efficient current would be 150 amperes; at 85 per cent. power factor, 100 amperes; at 90 per cent. power factor, 50 amperes, etc., up to 0 amperes, with a non-inductive receiving circuit.

What is stated here about changing the field excitation so as to maintain a maximum efficiency can also be applied to the question of changing the field excitation to get the best regulation of the generator, or what is the same, the best compounding.

We will now proceed to determine the most economical synchronous motor to be installed in a plant which consumes a constant power.

In this case the gain by installing a synchronous motor will be found in the reduced $c^2 r$ loss of the line, that is, directly in the coal pile of the station.

Using the same symbols as before we have then the total current in the line before compensation $= \frac{c}{\cos\phi}$;

total current in the line after compensation $= \sqrt{c^2 + (c\tan\phi - c_1)^2}$

gain in $c^2 r$ loss in the line

$$\frac{c^2 r}{\cos^2\phi} - [c^2 + (c\tan\phi - c_1)^2] r = (2cc_1\tan\phi - c_1^2) r$$

thus we get for maximum economy

$$(2 c c_1 \tan\phi - c_1^2) r k_1 - p k c_1 E \text{ equals a maximum,}$$

$$\text{or } c_1 = c\tan\phi - \frac{p k E}{2 r k_1} \qquad (E)$$

This equation gives us thus the most economical synchronous motor.

The saving in cost derived from the use of this motor, even after the interest on the investment of the synchronous motor is paid, is found by the following equation:

$$S = \frac{1}{100}\left[2 c^2 \tan\phi^2 - \frac{2 c p k E \tan\phi}{2 r k_1} - \left(c\tan\phi - \frac{p k E}{2 r k_1}\right)^2 - p k E c \tan + \phi \frac{p^2 k^2 E^2}{2 r k}\right.$$

$$\text{or, } S = \frac{(2 r k_1 c \tan\phi - p k E)^2}{400 r k^1}$$

The value of the power-factor in the new system is,

$$\cos\phi_1 = \frac{c}{\sqrt{c^2 + (c\tan\phi - c_1)^2}} = \frac{c}{\sqrt{c^2 + p^2 \frac{k^2 E^2}{4 r^2 k_1^2}}}$$

As seen, it is constant, and independent of the previous power factor of the load.

(To be continued.)

Motor Cars in London.

Saturday, Nov. 14, according to our English correspondent, was the date on which the Locomotives on Highways Act (1896) went into force. On this occasion some 50 cars assembled outside the Hotel Métropole, London, and started thence to Brighton, *via* Reigate. Six electric cars took part in this. The Local Government Board has issued regulations under the Act with respect to the use of "light locomotives" on highways. According to these regulations the expression "light locomotive" means a vehicle propelled by mechanical power, which is under three tons in weight unladen, and is not used for the purpose of drawing more than one vehicle, such vehicle not exceeding four tons in weight with its locomotive. The light locomotives are not to exceed 6½ feet in extreme width, are to have two independent brakes in good working order, and are to carry a white light in front and a red light behind. Although the Act contemplated a maximum speed at 14 miles an hour, the Local Government Board was empowered to fix any lesser maximum that it thought fit.

Insulated Wires and Cables, Their Construction and Design —Insulation; Its Efficiency and Defects.

BY J. DRAPER BISHOP.

(*Continued from page 630.*)

Fibre Insulated Cables.—There are two conditions in which fibre is used for insulating cables, the raw hemp jute fibre, and the manufactured product of pure manila rope fibre, paper. Neither of these can for a moment be considered as insulators in the sense applied to gutta-percha or india rubber. They are both, at best, only non-conducting materials playing the part of mechanical separators between the conductor and the lead sheath in which they are invariably enclosed.

Excepting cotton, which has passed entirely out of use, these are the oldest of all cables, being coëval with the glass, wooden and porcelain bead insulation period, when anything which did not "conduct" was deemed an "insulator." Their usefulness, however, diminished in proportion as the demands of underground and submarine work increased, and they were for many years relegated to obscurity, there to remain until the advent of the continuous lead press offered them the protection they required to make them serviceable, by enclosing them in a seamless, jointless and absolutely waterproof sheath.

In the mean time, however, the cause of their uselessness was discovered, but all attempts to make them waterproof failed. Cotton, silk, jute, hemp of all kinds, leather, linen, paper, rawhide and horse-hair were treated with solutions. Sealing wax, resin and shellac, varnishes, tar, pitch, asphalt, bees-wax and tallow, oil paint and sand are but a few of the many scores of hope-blighting experiments made to prove the survival of the fittest in the shape of gutta-percha and India rubber. But with the continuous lead protection the success of fibre cables was at once assured.

Still, as already suggested, these cables, whether for use in telephone cables or power circuits, cannot rely for insulation on the fibre alone. The application of the fibre to the conductor must necessarily be intermittent and irregular, leaving, with raw fibre, but not with paper, direct lines of air space between the conductor and the sheath. These air spaces are points of weakness electrically, which we shall speak of further on; physically they serve to collect and distribute moisture, which would eventually ruin the cable were not radical means taken to prevent it, not only during the process of manufacture, but during its subsequent life. Luckily such means are easily and reliably at hand, and any break down of fibre cable from the entrance of moisture is not nowadays attributable to aught else than accidental damage to the lead, culpable negligence or design.

The process of manufacture of any fibre cable is exceedingly simple. The fibre is wound around the conductor to the required diameter. It is then put in a hot air oven, heated to about 220 degrees Fahr., where it is allowed to remain until every vestige of moisture has been dissipated. But this requires care; if heated too much or too long the fibre becomes scorched or at least brittle; if too little, the cable will test out low. However, when thoroughly dried it is either passed through a "compound" and lead directly to the lead press, or it is plunged bodily, reel and all, into a tank of boiling compound, where it is allowed to remain until the cessation of air bubbles coming to the surface announces thorough saturation. It is then lifted from the tank and at once "leaded."

The compounds mostly used are resin and resin oil, sometimes disguised with a little ivory or lampblack, mixtures of heavy hydrocarbons with asphalt, ozokerite, bituminous pitches or some equivalent inorganic substances whose proportion vary with the requirements of temperature and climate. There are no compounds capable of universal appliance. A compound which would be firm and pliable in Summer would be hard and brittle in Winter, and one which would be firm and pliable in Winter would be fluent and leaky in Summer. Every manufacturer has his own ideas as to the best compound, which is supposed to be a secret, with relation to which my previous remarks on the secrecy of India rubber compounds apply with equal force.

Some times, however, in paper cables for certain purposes, notably for telephone work, and to secure a very low inductive capacity, no compound at all is used, the lead sheath being put on immediately on its removal from the oven, or as it ought to be done, without removal from the oven, the cable being passed through a hole in the door of the oven which is within a few feet of the lead presses. In this case the paper is in a state of high sensitiveness to moisture and must not even be handled. The heat of the conductor on the interior, however, assists to keep it hot and repel atmospheric moisture until the hot lead covers the exterior, but even now it is evident that some means must be used to keep moisture from entering at the ends. This is easily done by pouring melted paraffine in until a few feet of pipe are filled, which on cooling hermetically seals the ends and excludes the moisture. But this must be carefully done, for on the cable cooling down a partial vacuum is formed, which will induce the entrance of moisture into the cable through the smallest pin-hole or fissure.

But whether "dry" or "compounded" of raw fibre or paper, some arrangement is necessary for the exclusion of moisture during the life of the cable at the points where junction is made with overhead lines or interior leading wires. This is cheaply and effectually done by means of air-tight metal connection-boxes or terminals supplied by the maker.

The life of such a cable so protected must be almost unlimited; in fact, cables of raw fibre are at present in use which were laid by the Standard Underground Cable Company, so far back as 1882, and are still giving good service.

For currents of low potential it seems hard to see how such a cable can fail—but for currents of the highest potential yet known, or ever likely to be used, the paper strip cable is victor in the battle of volts *versus* cables. The first ever made of these paper-strip cables was made under the superintendence of the writer for the Chicago Arc Light & Power Company, some six years ago, and is, for all I know, still in use. It was insulated with paper strips, all laid on as closely and tightly as possible with overlapping layers and spirals, and compounded with resin and resin oil. But it had constructive defects which do not appear in later cables.

The closely pressed and tightly wound overlapping of the strips prevented their sliding over each other when the cable was bent, and when to this was added the cementing properties of the resinous compound the result was a stiff inflexible cable with enormous voltage-carrying power, which, however, was likely to be greatly diminished by the air spaces, or partial vacua created by the fissures made by breaks in the insulation under the tension of flexure.

Under low temperatures it was almost impossible to sharply bend such a cable without almost converting it into a very fair imitation of an old "lead" insulation, but under temperatures which kept the compound plastic the cable was more flexible, while the insulation, when cut with a sharp and clean knife, had the smooth, homogeneous appearance and "cut" of gutta-percha.

But this was only exceptionally the case. Owing to the closeness of the strips the drying-out was not only difficult to accomplish but also to determine, while the compound instead of penetrating bodily to the conductor was filtered through the paper, the essential or finer part of the oil alone reaching the inner strips while the coarser resin was left on the surface. This rendered results uncertain. Efforts were made to drive the compound into the core by subsequent rebaking, for even in those days it was recognized that the resin oil was the spark-resistant, or disruption preventer, but results were not satisfactory, although there are at present underground and successfully working, at comparatively low voltages, it is true, many miles of such cable in Chicago.

These and other important considerations led to a design in the opposite direction. The paper strips instead of being closed down and overlapped on each other by pressure, were put on with but moderate tension, each two or three strips in reverse layers, and instead of being made to overlap were put on with an open spiral. This at once changed the whole range of the cables' qualities. The cable became more flexible as the strips slid on each other when it was bent, the drying out was more quickly and reliably done and the compound was allowed by the open spirals to permeate to the very surface of the conductor. Subsequent experiments led to other and better compounds, and the result was a cable of great uniformity, easily bent and of lower capacity than had ever before been obtained. A No. 6 conductor insulated with less than one eighth of an inch in thickness could not be broken down by any means at the disposal of the various experts to whom it was submitted. One, however, reported that he had broken it down, but I am afraid to mention the number of volts required.

With the enormous insulation resistance, running sometimes into tens of thousands of megohms, combined with the lowest attainable inductive capacity which characterizes these cables, the first meaning a wide margin at security from renewal charges and the second diminished coal bills, as well as considerations of first cost, one is led to wonder what mysterious influence is at work to prevent

the more general adoption of paper insulated cables for high voltage. The paper used in these cables is practically incompressible, no amount of ill-treatment, no amount of heat, either temporary or continuous, can possibly bring about eccentricity of the conductor, an advantage possessed by no other cable, while if under the action of the acids and gases ever present in the sub-soil of large cities the lead should be eaten away, it may still require time, varying from days to months, fors ufficient moisture to penetrate to cause either a "blow-out" or a "burn-out."

In locations where the proximity of steam pipes, boilers or other sources of heat would be such as to cause the compound to resolve into oil, the cable would still preserve its anti-disruptive quality, in spite of its apparently low insulation resistance, for it would still be only a conductor mechanically separated by paper from a lead pipe, full of about the best insulation for high voltage known, *viz.*, resin oil.

The Cables of the Future.—Having thus reviewed the two principal if not the only sterling methods of insulation, *viz.*, vegetable gum and vegetable fibre, we may conclude that each has its own points of superiority under dissimilar conditions and when used for different purposes.

A cable to be good must hold its conductor with absolute concentricity under all influences of heat and flexure. This can only be attained by the use of paper.

A cable should be absolutely water and moisture proof, only attainable with rubber.

A cable should have the lowest possible capacity and the highest possible insulation resistance, only attainable by the use of paper core, "dry" or uncompounded. Alone, however, such a core would be utterly worthless on account of its moisture-absorbing character.

These considerations would seem to point to a combination cable, composed of a dry paper core with rubber compound sheathing enclosed in the usual lead pipe. As the rubber pipe would have to take most of the compression and tension strain of flexibility, it goes without saying that such a coating must be seamless.

At first sight such a cable would seem to be one of perfect design, and nothing in past experience has appeared to justify the slightest doubt of its success.

Concentric Cables.—The earliest concentric cable in the writer's experience was laid in Paris in 1889 from the dynamos in Les Halles to the Elysée, to carry current to illuminate the palace on the occasion of a fête given by the late lamented President Carnot. From all I could learn at the time, it was a new departure in cable design, condemned perhaps on that account by men of reputed ability in cable work, and as strongly upheld by others whose opinions were equally worth consideration.

I was told that the design arose from the fact that no ordinary cable carrying that voltage would be allowed in the sewers or to come within a distance of some metres of any telegraph or telephone wires elsewhere.

Moreover, the time was so short that there was no leisure to meet the precautions insisted on by the authorities to avoid danger, other than by the concentric design.

At 4 o'clock in the afternoon the interior wiring of the palace was finished, but there was no chance to test it. The lamps were being screwed in while the cable was being fixed to dynamos at one end and to a converter at the other.

President Carnot himself took a great interest in this original work, but insisted on all being ready at a given hour.

New dynamo, new and original cable, new converters, new wiring and new lamps were all in place, but the employees at either end were unaware of the condition of affairs at the other, and to the anxious inquiries of the chamberlains, masters of ceremonies and Government electrical officials, no one could reply in satisfactory terms as to whether or not everything was ready, much less in working order. This was at five minutes to the time appointed, when to the surprise of all concerned at the Elysée the lights began to glow, the whole palace became beautifully illuminated and remained so. The success of this "working on the blind" was attributed to the quickness of laying and also the safety of the concentric cable.

A properly designed and made concentric cable seems to carry with it that conviction of safety, scientific forethought and general fitness which good work always carries to the mind of the practical and trained engineer. It looks like a successful solution of an economical labor problem—and gives one an impression of capability for speedy and reliable work.

Among our friends on the other side of the Atlantic the concentric system is gradually coming into increased use not only for "go and return," but for the three-wire system. But it has not made much progress in this country, perhaps because scientific reasoning and induction on electrical underground work do not here, as over there, stand first, demanding as a first condition the satisfaction of every theoretical acquirement at the expense of speedy and economical construction. The engineers over there seem to say "this is what we want, and it must be done," while over here the statement rather takes the form of a query. "This is what we want to get done; how near can we get to it, and what sacrifices can we best make to mechanical and labor conditions?"

There is more "give and take" in our constructive systems here. Our men here are proficient in the present method; quick and expert labor is not abundant, and to teach and risk a new system with hands already trained to very expeditious and satisfactory work is, I expect, a disadvantage outweighing other considerations, although under conditions extant in Europe concentric cables present undeniable advantages.

The single cable in use here is simple, easy to handle, draw in, splice, locate trouble and repair; joints are easily soldered and the conductors are easily accessible, demanding a minimum of exposure to our extremes of temperature both for the mechanic and the cable. The stanchest partisan cannot say as much for the concentric cable. It requires more insulating material, is less flexible, and more costly to make. Jointing is a difficult and tedious process necessitating loose pieces, mechanical contacts and a box filled with oil to enclose them all in—while, whether embedded in bituminous compound or drawn into a conduit, there is no economy in space occupied.

Neither to the practical engineer is it of much, if any, advantage to know that an accident, such as a blow from a crowbar, which would sever a single cable without further harm, would only reach halfway through a concentric cable with a possibility of causing much greater harm.

It will be perceived that the writer's objections to concentric cables are based on purely mechanical grounds, but the closer one studies the conditions under which underground work has to be done in this country the more importance these grounds assume.

(*To be continued.*)

The Harrison Telephone Company's Affairs.

A remarkable story comes from Chicago concerning the business methods of the Harrison International Telephone Company, a receiver for which was applied on Oct. 5, last. Mr. Edward M. Harrison was one of the defendants in the suit for a receiver, and in a long answer filed in the Federal Court in Chicago on Nov. 20 he makes some startling disclosures. It is stated that he practically admits all of the charges of fraud and wrecking and alleges that he was also a victim of President L. E. Ingalls and his associates on the Board of Directors.

Mr. Harrison alleges that the company is utterly insolvent, and that its assets have been squandered by officers and directors, who voted large salaries to themselves and money for mythical expenses. He joins in the petition to have the business wound up, and that the men who secured stock fraudulently be ordered to pay for it.

He says all the assets have been absorbed in the interests of the officers and stockholders defrauded. He asserts that the contract of May 4 last was not adopted at the annual meeting, transferring the telephone property to the International Construction Company, and he asks that it be set aside.

Mr. Harrison says that the men who were made directors were to receive 2500 shares at 20 cents a share for the use of their names, as part of a scheme to entice the public to invest in the $80,000,000 of capital stock, but as soon as they were elected directors they donated to themselves $2,000,000 each of the $50,000,000 treasury stock and voted stock to Mr. Ingalls without consideration. He says he was induced by the false representations of C. M. Ferree and A. L. Stone, the promoters of the corporation, to transfer to them a two-third interest in his patents and claims; that Ingalls was aware that the patents were worth only $300,000 when the company was incorporated with $80,000,000 capital on the pretence that a large sum was needed to fight the Bell Company, but really to delude the public into believing that vast sums of money had been invested by the directors.

Mr. Harrison charges Mr. Ingalls with falsifying the minutes of the May annual meeting, which he controlled by holding a big majority of shares.

Telephone Repeaters or Relays, and Repeating Systems—III.

BY THOMAS D. LOCKWOOD.

(*Concluded from page 627.*)

Second. Because the obstacles or difficulties opposing material advance or improvement in the telephone repeater are much more numerous, and more solid, and more tangible, than those standing usually in the way of appliance improvement.

Reaching this part of the question, let us try to classify the difficulties which confront the would-be improver.

A. Is a serious obstacle. It is the feebleness and smallness of the articulating vibration of the armature or diaphragm, produced by the magnetic vibrations of the receiving magnet at the receiving end of the first circuit, when compared with the original vibration of the transmitter diaphragm imparted thereto by the sound waves produced by the voice of the person speaking at the transmitting station.

Think of it ! At the transmitting station the person speaking may speak as loud as he pleases, and even when he uses an ordinary loudness of voice the impact is such as to produce in the diaphragm vibrations much greater than can be reproduced in the distant receiving diaphragm, when the line of the first circuit is of any considerable length and therefore subject to the losses of ordinary leakage and charge.

Yet it is this feebly vibrating diaphragm that we must rely upon to do the work of transmission on the second circuit.

The difficulty is a great one, and while it is appreciably present even in a short experimental circuit, it is greatly emphasized on a long one, and clearly shows that the voice current changes of the second circuit cannot, even at a point thereof close to the transmitter, be anything like as strong as they are at the transmitting end of the first circuit. This, among other reasons, explains why forms of repeaters which repeat well, and apparently with maintained loudness between two laboratory or short circuits, sometimes fail altogether to work when placed between the receiving end of one long line and the transmitting end of another. In actual work we therefore ordinarily have in the repeater a transmitting force weak relatively to that which can be applied to the original transmitter.

B. A telephone repeater, like every other machine, requires time for the performance of its natural functions and operations. The operation of a cause must take place in point of time before the production of an effect due to such cause. This statement may seem to be rather platitudinous, but it is one which, in considering telephone repeaters, must be kept in mind.

Every telegraph operator or ex-telegraph operator, who has worked a long telegraph line through several repeaters will readily understand and comprehend this difficulty. Even though a very ordinary operator, and one who knows little and cares less about reasons, he knows very well that when he undertakes to send Morse, through repeaters, he must set bounds to his speed of transmission, send heavy and steady, and elongate his dots; and he knows also that the longer his line and the more repeaters there are to work through, the more deliberate, careful and heavy must be his sending, in order that the sounder at the distant end may be able to follow him and deliver its message intelligibly.

The operator who *does* investigate knows the reasons why this is so. He knows that it is because the armature lever of every repeater in the circuit uses up a certain definite amount of time in its excursion between its contact and limit stops; that the amount of time so lost is equal to that lost by one repeater multiplied by the number of repeaters in circuit; and that the original sending and the length of the original dots and dashes must be increased in order that they shall still, after all this loss of time, be long enough to tell their story at the receiving end.

Just so in the electro-mechanical telephone repeater. The mechanical movement of the original sound-waves imparts mechanical motion to the original transmitter diaphragm, and this, through electrical variations in circuit number one, and magnetic variations in the repeater receiving magnet, results in similar mechanical vibrations in the armature or diaphragm of such receiving magnet. This second set of mechanical vibrations is then required to take hold of the work, to bring about a second series of electrical and magnetic vibrations, *viz.*, those of the line and distant receiver of the second circuit, and through them produce a third set of mechanical vibrations, giving motion to the ultimate receiving diaphragm that of the final receiving telephone.

Now, although we may perhaps reasonably assume that the time consumed by the electrical changes is relatively small, and that consumed by the magnetic changes is not great, we cannot fail to perceive that the time required to bring about the mechanical motion of the repeater diaphragm, and to impart the same to the second circuit, must by reason of the mechanical inertia of the movable parts be very considerable. When we add this to the electrostatic retardation of the circuit conductor of two long lines, and to the magnetic inertia of two sets of transmitting induction coils and receiving magnets, it is easy to see that a very perceptible distortion of signals is to be expected, and the expectation does not fail to be realized. The introduction of a repeater between two long lines is the introduction of a distorting agency.

It may be said that the telegraphic illustration is misleading, because the excursions of a telephone repeater diaphragm are not comparable to those of the lever of a telegraphic repeater. That is true; but neither are the few changes per unit of time required by the fastest transmission of the Morse alphabet comparable to the number of vibrations required per unit of time in the transmission of speech ; these mounting frequently to several thousand per second. And in such comparison we cannot lose sight of the circumstance that the speed of telephonic transmission vibrations cannot be regulated, as are those of telegraphy, by the employment of a skilled operator who modifies his sending to suit modified conditions.

C. The difficulty of making a telephonic repeater capable of readily working in both directions ; enabling either line to repeat into the other, simply by transposing the speaker and listener.

This was a very difficult thing to devise, and the problem was one which received no clue leading toward its solution from telegraphic practice ; for there automatic switches and circuit-changers were employed, and could readily be actuated by the mechanical motions of armature levers ; but in telephony such switches were not admissible, for the reason that telephone lines generally are worked directly by the public ; which could not, of course, be relied upon to turn switches or do anything but speak and listen.

D. The tendency of telephonic repeating and relay apparatus to sing; or to set up reactive vibrations, which operate to overpower the work which they are desired to do and to frustrate all useful result.

This phenomenon is indeed the same curious effect which was noticed by Prof. Hughes, and which rather oddly led him to assert that in the microphone the telephonic relay was already achieved.

When in a perfect or reciprocal telephone repeater the receiving magnet sets its diaphragm into vibration, and the transmitting portion is operated thereby, the new vibrations set up are, unless prevented, likely to react upon the receiving portion once more, through the agency of the second line circuit, and the legitimate message thus becomes confused and disturbed.

This reaction often takes the form of a loud musical tone which the receiving diaphragm emits, and transmits over both circuits, producing disturbing currents in them, and disturbing noises in the telephone receivers, which drown out the original sounds.

The difficulties *C* and *D* have been finally disposed of by the repeating construction and arrangement last described, and repeaters embodying the principles of the Edison patent of 1886 will be found to have overcome the difficulty *C*, and not to be troubled by the fault *D*.

For, by the arrangement of that patent, each line can by its own primary-induction coil winding operate a receiving magnet common to both, that being in circuit with the single secondary of the said induction coil; and the instrument is thus made capable of "relaying telephone undulations for either of two lines to the other" ; and by placing the transmitting portion of the repeater in a bridge or branch between the two main conductors, at a point between the primary windings of the two lines, any singing reaction tending to arise on either main line is promptly neutralized by an equal and opposite tendency in the other.

The operation of this system (which marks the close of the invention period of the repeater), can be better understood by referring once more to the diagrams Fig. 6 and 7. Suppose station *X* to be transmitting; the electrical undulations in main circuit *L* pass through the primary winding 3, and then divide, part passing through the other primary, 4, and to the second circuit direct, and part through the bridged secondary of the coil *J*. The windings 3 and 4 being in series, unite to induce similar undulations in the common secondary 5, and these pass through the receiving magnet *M*, which is contained with the winding 5 in the local repeating circuit. The receiving magnet acts upon the transmitter *T* which in turn develops voice currents in its local circuit, which includes the primary *p* of the coil *J*.

Another inductive operation transfers such currents to the secondary *s* which, being bridged or branched, is common to both main circuits, and from thence the voice currents pass out and over the second main circuit *Z2* for the operation of its distant receiver.

The relayed currents in the bridged secondary do not react upon the receiving magnet and introduce confusion, because that can only be reached inductively through the induction-coil *I*, and because the said currents reach the primary windings 3 and 4 at a point between them, and must therefore circulate through them in opposite directions, it being obvious that the resultant effect on the secondary 5 and the receiving-magnet in its circuit therefore must be and is zero.

At the present time no careful thinker would be willing to dogmatically limit the possibilities of scientific invention, discovery and expedient; but every one is entitled to a personal opinion, and it appears now, that while it is true, as I have stated, that a telephone repeater can readily be constructed which repeats from either of two circuits into the other, enabling the receiver of the latter to reproduce a pretty good copy of the original conversation, it is also to be apprehended that the face value of such a thing is greater than its real value.

Such a telephone repeater can be placed between the adjacent ends of two short main circuits (subscribers' lines for instance), or even lines several miles long, and can readily be operated so as to produce excellent reproduction. Under such conditions there is no trouble in getting good results ; results *as good*, in fact, as can be reached when the same two lines are connected as usual, and the two stations allowed to communicate directly. But nobody wants to do this. Nobody cares to employ a repeater between two lines, whose stations can work together without it as well as they can with it, because in that case it is a superfluous expense and a superfluous complexity.

And it follows that if two long circuits fitted similarly with an interposed repeater cannot show *better* general or all round results, or more satisfactory operation than the same two long circuits or two like ones, when operated directly, there is no advantage to accrue by employing the repeater and there can be no demand for it.

This, as I look at the subject, is exactly what has during late years prevented the commercial use of the telephone repeater. If it be placed between the adjacent ends of two long lines, the combined effect of the two difficulties *A* and *B*, it would seem, are at once introduced. We can scarcely expect the repeater to speak to its transmitting diaphragm as loudly as the operator speaks to the initial transmitter ; and if it doesn't, it is obvious that the voice currents in the receiving line will not be as strong as those in the transmitting line, and that the loudness of the speech reproduced will not be increased or even maintained

We have no reason to expect that the introduction of mechanical inertia at the middle of our line of communication is going to make the articulation of the receiver any better; and we have good reason to believe that the effect it does tend to exert on such receiver will be to make its articulation, at least to some extent, worse.

Under these conditions the only question we need ask ourselves is, whether there is any advantages in using such energy as remains at our disposal at the middle of the circuit, to work a second transmitter over using it through the remaining portion of the circuit to work a receiver direct? And in answering the question we have to bear in mind on the one hand, that by dividing the circuit into two, the losses from static charge are lessened ; and on the other, that the introduction of a repeater is the introduction of an additional complication and an additional instrument to be kept in working order ; and we may, perhaps, for the sake of being on the safe side, add the sub-question: If there be any advantage, whether it is sufficiently solid to warrant the additional complexity and risk?

As the present writer is not convinced that difficulties *A* and *B* have received their complete *coup-de-grace*, and as he has no great amount of faith in the speedy coming of their utter extinction, his disposition would be to answer both questions negatively.

While, however, with my present knowledge I see no place for the telephone repeater as a means for accomplishing the telephonic transmission of conversation over lines too long to be operated otherwise, it is fair to say that there may be other fields of usefulness awaiting its profitable occupation.

A very considerable amplitude of diaphragm vibration may readily be imparted to a repeater transmitting diaphragm, provided that the delicacies of articulation are not required to be maintained. This condition may occur in the transmission of instrumental, and much vocal, music. In this class of transmission the melody and harmony is the dominant characteristic, and loudness is of more value than quality. There is no difficulty therefore in appreciating the proposition that where music is to be loudly reproduced (especially when it is to be reproduced at a number of places simultaneously) the electro-mechanical repeater may be advantageously employed. And it is also conceivable that the telephonic repeater in its present form and perfection may find a useful sphere of operation between main and branch circuits, or in the transmission of press reports, where "drop" copies are to be furnished.

A main circuit may extend say 1000 miles between its terminal stations, and at several points along its route there may be important cities, 50 miles let us say on either side.

In such a case I should expect that a repeater of the kind I have last described could be placed at the junction or the side line with the main route, and could on occasion be relied upon to do good and fairly satisfactory work, repeating both into and out of the branch line.

The position adopted by this article in thus modestly estimating the commercial capabilities of the telephonic relay or repeater involves of course a liability that its range of profitable application may have been measurably undervalued. But all such judgments must assume the risk of a possible necessity of revision ; and if it shall so turn out, and if it shall by reason of eventual development ultimately appear that such instruments have a wider sphere of operation than at present seems to be promised, the gratification and satisfaction of the writer will be far greater than it can be, should time corroborate his measure of the powers of and applicability of repeating devices.

For when one is forced to adopt an extremely conservative view of an apparent advance in a useful art, or of a supposedly improved appliance, though it be indeed pleasant to have it recognized that we had correctly gauged the extent of the improvement, we necessarily experience a much keener and more reasonable pleasure in finding that we were wrong, and that the scope of the improvement was wider and broader than we had believed.

And any one making such a miscalculation may, moreover, find the happiness which he derives from the knowledge that the device he has discussed has a usefulness greater than he had been able to forsee, and that the world is by so much a gainer accentuated ; when he reflects that he is by no means alone, and that by the inexactitude of his foreshadowings he has become qualified for membership in the distinguished fraternity which includes the able electrician and author, Robert Sabine, who saw the duplexing of the telegraph perfected and made practically operative by Stearns almost before the ink was dry in that memorable passage in his *History and Progress of the Electric Telegraph*, which declares that all telegraphic duplex systems "must be looked upon as little more than feats of intellectual gymnastics, very beautiful in their way, but quite useless in a practical point of view ;" and the versatile and brilliant scientific writer and lecturer Dionysius Lardner, who, while proving it to be absolutely impossible for any ship to carry coal sufficient in amount to enable it to cross the Atlantic by steam power, was confuted by the news that the feat had just been performed and that a steamer had arrived.

Connecticut Street Railway Association.

The annual meeting of the Connecticut Street Railway Association was held in New Haven, Conn., on Nov. 18, delegates being present from New Haven, Hartford, Bridgeport, Waterbury, New Britain, Derby, Bristol and Norwalk street railway companies.

Matters of general interest to street railway managers were discussed at the meeting, and the election of officers for the ensuing year resulted as follows: President, H. Holton Wood, Derby; vice-president, Henry S. Parmelee, New Haven; secretary, E. S. Breed New Britain; treasurer, E. S. Goodrich, New Britain. Executive Committee—A. M. Young, Waterbury; E. Israel Kelsey and G. A. W. Dodge, of New Haven.

At noon time the members inspected the various street railway lines of the city, and at 3.20 o'clock p. m. the annual banquet of the association was held at the New Haven House.

The International Submarine Telegraph Memorial.

At a recent meeting of the Executive Committee of the International Submarine Telegraph Memorial, held in London, it was voted that "it is desirable to establish a memorial of the late Sir John Pender." It was also decided to take measures for promoting, in the year 1901, a general international memorial recording the Jubilee of International Submarine Telegraphy.

Electric Traction Under Steam Railway Conditions.*

(*Abstract.*)

Dr. Chas. E. Emery opened the discussion as follows:

In the light of recent achievements, it can be assumed at the outset that electric traction under steam railway conditions is feasible. The only question is whether it will pay. The present applications only prove the former proposition, but do not touch the latter.

The greatest practical efficiency of an electric system of the kind proposed between the engines at the central station and the rails would probably be 60 per cent. This, on account of a second transmission to sub-stations and the necessity of using rheostatic regulation to same extent, would probably be reduced to 50 per cent., so that twice as many horse-power would need to be generated at the central station as at the track with the present steam locomotives. Each horse-power in the central station will be developed for two pounds of cheap coal or four pounds per net horse-power delivered, whereas the steam passenger locomotive will on the average require six pounds, based on net tractive force and allowing for the various wastes. The saving in coal due to electric passenger traction will therefore be one third. Coal is procured cheaply by the railways, but probably an inferior quality costing 50 cents per ton, or say 25 per cent. less than that used on locomotives, could be employed in the electric stations, so that, for trains of like weight, the saving in *cost* of coal for passenger service would be $\frac{3}{4} \times \frac{4}{5} = \frac{1}{5}$. For freight engines we calculate the saving in cost for fuel will be about 55 per cent., and for switching engines about 66⅔ per cent. On railways running through the coal regions the total cost of coal is about 9 per cent. of the total operating expenses. A saving of one half in the cost of the coal then corresponds to a saving of 5 per cent. of operating expenses. For reasons that will be stated later, it is believed that, for general railway work, independent electric locomotives will be required, and that these will necessarily be as heavy as present steam locomotives, on which bases the only saving in weight will be that of the tender, which we have assumed as 10 per cent. of the total weight of the train for passenger engines, 3.3 per cent. for freight engines, and 5 per cent. for switching engines. The total load to be hauled will therefore be decreased by these several percentages, and the cost of coal reduced thereby to 45 per cent. of that required by the present locomotives for passenger trains; 43½ per cent. for freight trains, and 32 per cent. for switching trains. Applying these percentages for the relative amounts of coal used for these different purposes on a prominent railway, the average saving in fuel becomes 58.9 per cent. or 5.89 per cent. of operating expenses. The cost of water is taken at ⅘ of 1 per cent., on the same basis which increases the saving to 6.56 per cent.

Considerable savings have been claimed on other grounds. First, in relative repairs of electric motors compared with locomotives. Repairs will be less on the motors of course, but are not inconsiderable, and when we consider that the transmission line, trolley line and trolleys must be kept in repair as well as the motors, it cannot be far in error to assume that the question of repairs will be about balanced, independent of central-station apparatus otherwise provided for.

For reasons above given, it will be necessary to mount electric motors for fast locomotives away from the centres of the axles and connect through side rods, as in the present locomotives. The only other method would be to use chains, which are mechanically impracticable. There is another important reason for this. In order to obtain speed the motors must be wound for it so that the counter E. M. F. will be produced by velocity rather than the number of turns, and, in starting, the motors are necessarily connected in series so as to reduce the starting current. For motors adapted to very high speeds it will be necessary to put pairs in series even to surmount heavy grades, to act as pushers in case of accident, or in removing snow, etc. The counter E. M. F. is therefore divided between several motors, but not necessarily in equal degree. If, with motors connected to separate axles, one for any reason slips its wheels, it will monopolize the larger portion of the E. M. F. and cut down the current on all the motors in series so that full power cannot be obtained. Working the motors in parallel with an enormous rheostat would be wasteful and, in some cases, impracticable. It is therefore important for two reasons to connect driving wheels operated by separate motors by means of side rods.

Again, it is essential that, on the road, speed be regulated by better means than a rheostat. A series-motor varies its speed with the load and so cannot run without rheostatic regulation at a given speed if for any reason the number of cars in the train or the track resistance varies. It will therefore be necessary to return to commuted series field coils or equivalents, and it will be perhaps desirable to have a shunt winding which can be used to give still closer regulation. In fact, shunt motors are being introduced abroad for traction purposes. The use of these devices will increase the weight of the motors compared with simple series-wound motors for the simple reason that with the field reduced to the utmost it must still be sufficient to prevent sparking, and there must be sufficient iron employed to make the stronger field efficient when it is desirable to run slower. These considerations make more room desirable for the motors than can be provided in the trucks of an ordinary car.

For these several reasons it is predicted that the high-speed electric locomotive of the future will, like the steam locomotive, be a structure independent of the train, that the motors will be hung on the frame independent of the driving wheels and the same as well as the driving wheels connected by side rods. To obtain proper room under such conditions larger driving wheels will be employed than the wheels of an ordinary car. This will so extend the wheel base that it will not be safe to run at high speeds without the leading truck the same as on an ordinary locomotive, and in fact the electric locomotive will in all its general features be a steam locomotive without the boiler, with motors substituted for the steam cylinders. In this way and probably in no other can the flexibility of the present steam locomotive be obtained. Probably there will be greater difference of opinion on this subject than on any other. The use of motors in the trucks of baggage cars is so fascinating that strong efforts will be and should be made to retain such a system, though the reasons stated are believed to be sufficient to prevent its general adoption. Again, it is desirable that the whole locomotive be a unit on a strong frame calculated to resist the shocks due to collisions and accidents, and it is doubtful if locomotive drivers will be found who will be willing to risk their lives on any other kind of a structure.

On the whole, therefore, although the application to the whole length of long trunk lines does not seem practicable under present conditions, there is no doubt but that the industry will grow in the future as certainly as in the past.

Mr. Charles H. Davis (communicated): The subject of "Electric Traction Under Steam Railway Conditions" can be divided into a a consideration of:

1. New roads to be built.
2. Old steam roads to be partially or entirely changed over.

The relative merits of the use of "Electric Traction" or "Steam Locomotive Traction" in each of the above cases can be considered under the heads:

First cost.

Total expenses { *a.* Fixed charges. *b.* Maintenance. *c.* Operating expenses.

Gross receipts.

1. NEW ROADS TO BE BUILT.

First Cost.—The cost of right of way, stations, terminals, fencing, grading, ballasting and track will be approximately the same in either system. Overhead line work or third rail and feeder system, including track, ground and feeder returns, are not required for steam traction and their cost is an additional charge against electric traction. The cost of equipment, excluding locomotive, is in favor of steam traction, as roughly it may be considered that the motors and controlling devices or the electric locomotive are the items making up the increase in first cost of electric traction. In the first cost of power plants we can assume buildings to be nearly the same—several round-houses as against fewer power-houses. The steam and electrical plants, including foundations and stack, will not only exceed the cost of locomotives and tenders per horse-power, but in the use of central electric stations a great amount of horse-power must be installed. This is especially so when lines are very long, making it necessary to duplicate the central station or use sub-stations, or both, before it becomes necessary to duplicate locomotives by changing them. Should the headway of trains and their weight and capacity become similar to street-railway practice in large cities then, and only then, would electric power be less in first cost than steam locomotives; if the total power required were large this might even result in lower first cost of the entire system.

No attempt has been made to give figures, as each individual case

* A topical discussion at the 109th meeting of the American Institute of Electrical Engineers, New York, Oct. 21, and Chicago, Oct. 28, 1896.

must be studied and the difference in first cost determined; but it will in general result in favor of locomotive traction with the exception noted.

Total Expenses.—a. Fixed Charges: These will be greater for electric traction owing to greater first cost, except in the one case mentioned above.

b. Maintenance: This subject is too wide to be fully discussed here, but it can be assumed that permanent way, track, car bodies, trucks and other items, the same in each case, would be maintained at equal cost. It is probable that the cost of maintaining the power plant, motors, line, etc., of electric traction would exceed the cost of maintaining locomotives, tenders, etc., and that the saving due to less wear and tear on track and rolling stock in electric traction would not make up for the difference.

c. Operating Expenses: A general conclusion would be that the question of total expenses depends so largely upon each individual case that only a study of it will enable one to arrive at a reliable result; but that with light weights, small capacity and frequent service electric traction can be operated cheaper than locomotive traction.

The conclusions one arrives at is that for long lines, infrequent service, where freight is a large proportion of the business, and where centres of population are far apart, the steam locomotive is the only paying method of to-day, as the first cost will be less, as well as total expenses. The writer has had several opportunities of determining these facts. What development may bring to electric traction in the far future cannot be foretold.

2. OLD STEAM ROADS TO BE PARTIALLY OR ENTIRELY CHANGED OVER.

First Cost.—What has been said under "new roads" will apply, with the additional disadvantage in the use of electric traction due to the increased first-cost arising from the necessity of throwing away old steam equipment, either in part or whole. In some cases this would be unnecessary, as with large systems, where existing equipment could be used on that part where electricity did not replace steam locomotives.

Total Expenses.—Remarks under "new roads" will apply; and it would therefore appear that unless steam railways can change the character of their service to more nearly conform to street railway practice, they will be in many cases unable to adopt electric traction in place of steam locomotives to their own profit.

Gross Receipts.—What has been said under "new roads" again applies; therefore existing steam roads, to increase their gross receipts, must give quicker and more frequent service, and must give as near as possible the "leave at your door" service.

Conclusions.—The writer believes that electric traction will be profitable to steam railway systems when some or all of the following conditions are fulfilled, depending upon the special problem to be solved:

1. Steam railway managers must avoid making the mistake which took place in the change from horse traction to electric traction, namely, of trying to reduce the first cost of changing by the use of old methods, material and equipment, which, although entirely suited to the old system, proved most unsuitable under the new conditions. The tendency is to repeat this mistake, and too much stress cannot be laid upon avoiding it.

2. Long distance, heavy trains and infrequent service, if a necessity, will prevent electric traction being profitable. Therefore, where gross receipts can be increased by light trains and frequent service, and thus decrease expenses, as compared to steam locomotives, electric traction will prove profitable.

3. Steam railways where the second condition is fulfilled can better the results where they operate part of the system on the "leave at your door" plan. This suggestion may seem to some a radical departure, but I commend it to the careful thought of those interested.

Polyphase Motors.

According to an English writer it is found in German practice that polyphase motors will give about 30 per cent. greater output with 7 to 8 per cent. better efficiency than single-phase machines of the same price and weight.

Electrical Executions in Ohio.

On Nov. 21, in Cincinnati, O., Willie Haas was convicted of murder in the first degree, and it is stated that he will probably be the first condemned criminal in Ohio to suffer the death penalty in the electrical chair.

Volts vs. Ohms.

THE SPEED REGULATION OF ELECTRIC MOTORS.

In a paper read before the American Institute of Electrical Engineers at the meeting of Nov. 18, Mr. H. Ward Leonard referred to the system of control which has been brought before the electrical public on several previous occasions and also described some new features which have lately been developed by him. In the course of his remarks Mr. Leonard said:

The control of the speed of an electric motor from a state of rest to a state of full speed is a problem of rapidly growing importance to the electrical engineer. The operation by means of electric motors, of elevators, locomotives, printing presses, traveling cranes, turrets on men-of-war, pumps, ventilating fans, air compressors horseless vehicles, and many other electric motor applications too numerous to mention in detail, all involve the desirability of operating an electric motor under perfect and economical control at any desired speed from rest to full speed.

The most commonly practiced method of controlling the speed of an electric motor for such applications at present involves the use of ohmic resistance in the circuit of the motor armature, which resistance is varied to control the motor's speed.

The use of an ohmic resistance for controlling the speed of an electric motor results necessarily in a waste of energy, and in an unstable control of the speed. The object of this paper is to endeavor to show the advantages arising from the use of a system of motor control having several modifications, but all of which involve the idea of controlling the speed of an electric motor by controlling the E. M. F. generated in its armature circuit, and without using any regulating resistances in that circuit.

The new features which Mr. Leonard explained are shown in Fig. 1. *G* is a source of 125 volts constant E. M. F. *S* is a shunt-wound dynamo connected across the constant E. M. F., and hence running

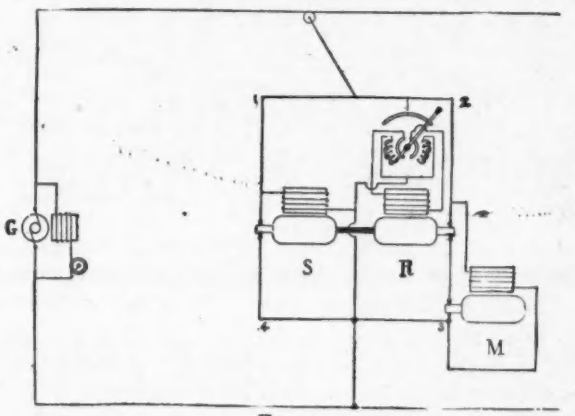


FIG. 1.

at a constant speed. *R* is a dynamo mechanically connected to drive or be driven by *S*, and running at a practically constant speed.

The field of *R* is excited by the main line E. M. F., and is independent of the E. M. F. of its armature and of the current through its armature. It has a variable and reversible field rheostat in circuit by means of which the magnetism of the field of *R* may be varied and reversed at will. *M* is the working motor. Its armature is in series with the armature of *R* across the line. Its field is excited by the main line E. M. F., and hence is independent of the E. M. F. or current of the armature *M*.

Suppose that the armature of *S* is wound for 125 volts and 100 amperes. The armature of *R* for 125 volts and 100 amperes, and the armature of *M* as in the former illustration for 250 volts and 100 amperes.

Neglect the armature losses for the sake of simplicity, and because they do not materially affect the conclusion.

Suppose that we want to run *M* at one tenth of full speed under full torque, full speed being 500 revolutions per minute and corresponding to 245 volts counter E. M. F. and full torque being that due to 100 amperes in the full field.

At first let us have the rotary transformer *R S* so adjusted that the fields of *R* and of *S* are both fully excited. Each end takes a slight current through its armature. Both ends are motors, and they divide between them the friction load.

Now let us weaken the field of *R* until its field strength is only nine tenths of its full strength. *R* in this weaker field tends to

run faster; but in doing so it is obliged to drive faster the armature of S whose counter E. M. F. has been almost equal to that of the line.

The dynamo S now acts as a generator and has two paths open for its current, the first being the circuit through the generator G and the other path being in the closed loop through R and M.

The E. M. F. of G balances that of S, but the E. M. F. of R, which formerly was equal to that of G and also that of S, has been reduced by the weakening of its field, hence S sends a large current through the local circuits 1, 2, 3. 4, causing a large torque in the armature of M, in its constant field. M evidently will run at a speed such that its counter E. M. F. plus that of R equals the line E. M. F.

Expressing the conditions in figures under the assumption made, there will be upon the terminals of M 25 volts and through its armature 100 amperes; that is, a total of 2500 watts in the armature of M. The armature of R will have 125 — 25 = 100 volts and 100 amperes or 10,000 watts, and the armature of S will have 125 volts and 80 amperes; that is, 10,000 watts.

The generator G produces 20 amperes at 125 volts or 2500 watts, which, by the method described, is transformed into 25 volts and 100 amperes at the working motor.

By continuing the weakening of the field of R, we finally have a field of no strength, and hence R becomes inert and we have the full line E. M. F. of 125 volts upon the 250-volt motor M, which consequently runs at half speed. Under these conditions no energy is transformed by the rotary transformer R S. If, now, we reverse the connections leading current to the field of R, and send a gradually increasing current around its field, its voltage is added to that of the line instead of being counter as heretofore, until finally its full voltage of 125 being added in series with the line E. M. F. of 125 volts, we have upon M 250 volts and it runs at its full speed. While R is thus adding to the line volts it of course is acting as a generator instead of a motor, which it formerly was, and is now driven by S, which acts as a motor instead of a generator.

Attention was called to the fact that the current capacity of all three armatures, R, S and M, is equal, but the full E. M. F. of R and S is each only half that of M, which means that the kilowatt capacity of R and S is each only half that of M.

The rotary transformer R can also be designed to run at much higher speed than is demanded for the working motor, since it can be perfectly balanced and is free from any side or end thrusts and has a minimum friction.

Preliminary Note on the Color of X-Ray Fluorescence.*

PARKER C. M'ILHINEY.

During a study of the appearance of calcium tungstate under the influence of the X-rays, it was observed that the color of the light was not always the same. This led to an investigation of the conditions affecting the color. It appeared from the first experiments that the color of the light was affected by the size of the crystals, and to investigate this point a large quantity of tungstate, amounting to perhaps 10 pounds, was obtained from Sibley & Co., of New York. It was first examined with the microscope and found to be free from amorphous tungstate and to consist almost entirely of crystals of the same form, differing only in size except for a small percentage of another kind of crystals which were separated and found not to be responsible for the differences in color. The whole sample was separated by sifting into 10 different sizes and of each size a portion was spread upon a square of pasteboard. The screens so made were then submitted simultaneously to the action of the X-rays emitted by various Crookes tubes and the effect studied both by examination with the eye and by allowing the light produced to act upon photographic films. The photographic experiments were made by placing the screens facing upward in a pasteboard box, laying over them a piece of bromide paper with the film side down in contact with the screens, closing the box light tight and exposing to the rays. When examined with the eye it appeared that the screens covered with coarse crystals emitted a yellowish light and that the color progressed regularly from the red toward the blue end of the spectrum as the crystals became smaller while the very small sizes gave scarcely any visible light at all. This made it seem likely that the fine crystals were emitting ultra-violet light and the photographic experiments confirmed this, for the portions of the bromide paper in contact with the fine crystals were as much darkened as those in contact with the coarse crystals. It thus appears that the size of the crystals of calcium tungstate influences the color of the light; the smaller the crystals the shorter the wave-length of the fluorescent light.

It is the author's intention to investigate the fluorescence of other substances along similar lines, using both the X-rays and ultra-violet light.

* Read before the New York Academy of Sciences, Section of Astronomy and Physics, Nov. 2, 1896.

The Division of an Alternating Current in Parallel Circuits with Mutual Induction.*

BY FREDERICK BEDELL.

A divided circuit with mutual induction between the two branches is the same as a transformer with the primary and secondary circuits connected in parallel. The problem may be treated in the same manner as that of the transformer. The E. M. F. equations for the two circuits are similar, the internal E. M. Fs. in each being equal to the same impressed E. M. F. The E. M. F. of mutual induction will be positive or negative according to the sense or direction in which the coils are connected. If the coils are connected so that the ampere-turns of the two coils assist each other, the E. M. F. of self and mutual induction will be of the same sign, and the coefficient of mutual induction will be positive. If the coils are connected so that the two oppose each other, the E. M. F. of mutual induction will be opposed in sign to that of self-induction. The coefficient of mutual induction may accordingly be plus M or minus M. Writing the E. M. F. as a function of the time, the E. M. F. equations for the two circuits are:

$$e = f(t) = R_1 i_1 + L_1 D i_1 \pm M D i_2 ;$$
$$e = f(t) = R_2 i_2 + L_2 D i_2 \pm M D i_1 ;$$

where e and i represent current and E. M. F., R and L represent resistance and self-induction, and D stands for the operator $\frac{d}{dt}$. The solution of these equations gives us the values for the currents in the two circuits and their phase relations. Where the coils are opposed and nearly similar, the angle of phase difference between the currents depends largely upon the amount of magnetic leakage.

The graphical treatment of the problem shows this relation more clearly The E. M. F. to overcome the resistance of each circuit is represented by a vector in the direction of the current. The E. M. Fs. of self and mutual induction are at right angles to the currents in their respective circuits. This gives us three vectors for the E. M. Fs., in either circuit, and the sum of these three vectors in either circuit is equal to the E. M. F. impressed upon the two circuits. The direction of the vector representing the E. M. F. of mutual induction depends upon the sense in which the coils are connected.

The equivalent resistance and self-induction of the two coils together, whether they are additive or opposed, may be found by resolving the E. M. F. into two components, one in the direction of the main current and the other at right angles to it. The resultant of these components may be obtained graphically and from them the values of the equivalent resistance R^1, and the equivalent self-induction L^1. The equivalent resistance and self-induction of their branches may be obtained in the same manner.

Particular cases may be discussed by assuming definite values for the constants of the circuits or definite relations between them.

* Abstract of paper read at the British Association for the Advancement of Science.

Horseless Carriages.

Mr. Joseph Sachs delivered a lecture before the New York Electrical Society, at Columbia College, on the night of November 19, on the subject of "Horseless Carriages." The lecture consisted of a brief review of the development of this class of vehicles.

The first self-moving vehicle, he stated, was proposed by Sir Isaac Newton. It was to be propelled by the reactionary effect of exhausting steam, and had no mechanism whatever. The development of self-propelling vehicles was retarded for many years in England by stringent laws, but in recent years interest in this direction had been actively revived, resulting in the production of steam, gas and electric wagons.

Mr. Sachs divided his subject into two main classes, viz., the hauling or locomotive class, and the class in which the power and carrying capacity were combined in one vehicle.

The design and construction of self-propelling vehicles should receive special consideration. To apply propelling mechanism to any vehicle was hardly in line with good practice. The construction of the vehicle body should be light and strong. The tubular construction, Mr. Sachs said, seems to be the coming form. The vehicle

must not be top heavy, on account of the danger of upsetting in turning corners. For this reason the tendency has been, he said, to place the centre of gravity as low as possible.

Regarding the speed of motor vehicles, the speaker thought that 10 miles an hour would be generally adopted as the best average speed. Low speeds were preferable to high speeds, which were attended with dangers in city streets.

The tractive weight and power capacity of horseless vehicles should have proper relations with one another. Excess of power under normal conditions means excess of weight to carry.

The matter of wheel construction was a very important element in the design of this class of vehicles, the speaker said. The wheels, besides fulfilling the functions of wheels, also act as propellers, and for this reason they should be strong. The ultimate design would probably be a metal wheel with tangent spokes, thus securing maximum strength with greatest lightness. The best tractive results are obtained when the power is applied to the wheel as near the rim as possible. By this method the twisting action on the wheel is avoided. Rubber tires give the best results in practice and should be puncture-proof. They possess superior tractive effect and avoid side thrust on the axles.

The motor question was not a simple problem. The conditions demand a light, compact and automatic machine, operating at the highest efficiency at the lowest cost—all very important factors. The motor must give maximum energy and have smallest bulk. Reciprocating motors, such as those of the steam and gas types, were very objectional on account of vibration, heat and odors.

The location of the motors was also an important consideration, and the method of connection with the driving wheels is a factor of great importance. Great loss of energy can occur here.

Steam motors were next considered. The main advantage of this class of motor was ease of control, but the disadvantages were great. The efficiency of the small engine was very low, and the discomforts due to the exhaust, heat and vibration, were pronounced

As regards the gas motor, the speaker stated that the principal advantages were that it was entirely complete in itself, its large fuel-carrying capacity and cheapness of operation. Two types of gas motors were available, the Otto cycle and the single revolution explosion type, a majority of the efficient gas engines being of the Otto cycle principle. The disadvantages of the gas motors were many, however. They could run only at one speed; they must be started manually or by the application of other external power, and they will not start on a load.

The electric motor vehicles next received the speaker's attention. The advantages of the electric system were simplicity, ease of control, and facility of connection of power with driving wheels. The steering devices and brakes can be operated by electric power, and such a machine cannot be stalled. Since it is necessary to depend upon the storage battery for supply of power, the disadvantages of the electric system were the great weight of the battery, the limited supply of energy, the mechanical disintegration of the plates and the lack of facilities for charging the batteries. The horseless carriage service, the speaker stated, was harder on storage batteries than traction work. He thought that a vehicle *par excellence* would be one combining the electric system with an outside source of supply. A dynamo operated by a gas motor, *a la* Heilmann locomotive, would probably produce effective results. With all its disadvantages, however, the electric vehicle was superior to either of the other types.

In conclusion, Mr. Sachs stated that the difficulties now met with would certainly be surmounted, and that the horseless vehicle would occupy a very important place in everyday affairs.

Mr. Sachs showed on the screen views of horseless vehicles of every imaginable design, in all three classes—gas, steam and electric—and briefly explained the special and important features of each. The electric vehicles represented the most rational ideas.

Among the electric vehicles thus shown was the Riker carriage, which captured the first prize at the recent contest in Providence, R. I. This vehicle was equipped with two 1½-hp motors.

Among the earliest electric vehicles was one made by the Holtzer-Cabot Electric Company, of Boston, an illustration of which was also shown. It was propelled by one 4 hp motor, which derived its power from 40 storage cells. The Morris & Salom carriage was also shown on the screen. This vehicle took the second prize at the Providence contest. It was propelled by a Lundell motor.

A Riker carriage motor was exhibited and the lecturer referred to it as combining great power with light construction.

Electrolytic Condensers.

BY ALBERT G. DAVIS.

It has been known for some time that the electrolytic cell was a substitute for the condenser, and could be used to advance the phase of an alternating current, and the patent was held by the Stanley Electric Manufacturing Company up to last week. But on Nov. 17 there issued to Hutin and Leblanc, the well-known French inventors, a patent which covers the idea quite broadly. The first claim is: "In combination, with an electric circuit possessing self-induction, charged with alternating currents, of an electrolytic polarization-battery having a sufficient number of cells in series to neutralize by polarization the E. M. F. of the self-induction of the circuit, substantially as described."

In the Hutin and Leblanc Belgian patent of Jan. 9, 1891, the inventors show their well-known alternating motor in which the two-phase currents are obtained from single-phase by the use of a condenser, and state that a polarization or electrolytic cell will serve as a substitute for a condenser in any of the forms which they describe. Relying on that disclosure, they filed the application on which patent has just issued and won an interference with the above named company. But in the testimony there were brought out references which caused the office to again reject the case after the interference was decided. It appeared that Mascart and Joubert, in their work on Electricity, had shown that the counter E. M. F. of a cell when charged with a low current is proportional to the total charge. This is also true of the condenser. And the work also gives equations connecting the frequency, self-induction and size of cell for the condition of perfect neutralization of self-induction. This, in connection with an old article of Maxwell on the use of a condenser in circuits with self-induction, was construed to anticipate the claims.

But a series of arguments were filed, and the case at length went to issue, so that the ownership of this particular property is changed, after a hotly contested fight. The invention is not of the great importance which it was at one time supposed to be. The analogy to the condenser fails in one important respect. The conduction through the liquid is a positive one in the eletrolytic cell, and in the condenser is merely a dialectric displacement current. In the latter case there is no C^2R loss; in the former it is a very serious factor. This fact has prevented the use of the electrolytic cell on a large scale in commercial work, though there is no known reason why it should not be useful in starting single-phase motors, where it need only be connected in while the machine is getting up to speed, as of course either the synchronous or the induction motor will run with a single-phase inducing member after it once attains speed.

Owing to the long life of the Belgian patent, the American case does not expire until Jan. 9, 1911.

Standard Cells.

To the Editor of The Electrical World:

SIR:—Two or three typographical errors of some importance occurred in my article on "Standard Cells," published in your issue of Nov. 14. In the quotation from Mr. Heinrich, instead of "its E. M. F. was probably 0.02 per cent. of one volt," it should be "its E. M. F. was within probably 0.02 per cent. of one volt." Further on the E. M. F. of the No. 5 calomel cell as found by the silver voltameter, should be 1.0010 instead of 1.6010 as printed. In the same connection the temperature coefficient used in the reduction for these cells is 0.01 per cent., and not "1001 per cent." HENRY S. CARHART.

UNIVERSITY OF MICHIGAN, ANN ARBOR, MICH.

Insulated Wires and Cables.

To the Editor of The Electrical World:

SIR:—While thanking you for your complimentary editorial remarks on my article on "Insulated Wires and Cables," the first installment of which appeared in your issue of the 14th inst., I would also point out that, unwittingly, you scarcely do me justice.

You remark: "Mr. Bishop asserts that the supply of rubber is practically inexhaustible."

What was printed was (page 592, last three lines of first column), "The supply seems to be well nigh inexhaustible," and what my notes show is that I wrote, or at least intended to write, the "*area of supply*," and this intention is supported by the context. It is perhaps only a difference of "tweedle dum and tweedle dee," because I agree entirely with your following remarks on this subject.

In fact, I myself had written somewhat extensively in the same strain, but on revision eliminated this part, fearing it would unduly lengthen articles already too long perhaps.

In the paragraphs above the remark just quoted, the words "general potential" are used two or three times for "gutta percha," but the substitution is so obvious that it will scarcely confuse an intelligent reader; however, I call the attention of the "printer's devil" to it. J. D. Bishop.

New York City.

The Heilmann Locomotive.

To the Editor of The Electrical World:

Sir:—I have read with interest in The Electrical World, of Oct 24, an article by Mr. H. Ward Leonard on "The Heilmann Locomotive," in which he endeavors to show, among other things, the great saving in fuel consumption as against such locomotives of our standard type as are used on the "Empire State Express."

Taking the figures given in the above-named article, which are very incomplete in regard to the performance of the Heilmann locomotive, seems to show that an attempt to run this train by the latter locomotive would be a very poor investment.

The figures given show that the coal consumption of the Heilmann locomotive is .32 pound per ton mile behind the drawbar. Taking the average horse-power of the "Empire State" locomotive on a round trip between New York and Albany as 1050, with a coal consumption of 3.125 pounds per horse-power hour, gives a total coal consumption per hour of 3281 pounds. The ton miles per hour will be 9000, which gives a coal consumption of .36 pound per ton mile.

The service of this train would be 49,640 ton miles per day, or 14,892,000 ton miles per year. Our saving then in fuel amounts to .04 pound per ton mile or 298 tons per year. With coal at $2.50 per ton, this would show a saving of $745 per year.

Allowing 10 per cent. for interest, depreciation, etc., gives an allowable investment of $7450 in addition to the cost of the standard locomotive, which would bring the total investment up to $19,450, allowing $12,000 for the cost of the standard locomotive.

If the machine could be produced for the above sum the two investments would just balance, calculating on the fuel alone, but it seems hardly necessary to point out the fact that the above sum would not purchase 1050 horse-power in boilers, engines, generators, motors and appliances, to say nothing of the trucks and frames.

It is claimed that such a machine would be especially adapted to tunnel work on account of the freedom from gases, but as the freedom from gases or, in other words, perfect combustion, would be the result of excellent boiler construction, it would seem that the greater gain would be made by utilizing these perfect boilers, using the steam directly in locomotive cylinders instead of through engines, generators, controllers and motors, thus saving the interest on the greater investment. Sam H. Libby.

Schenectady, N. Y.

Röntgen Rays Act Strongly on the Tissues.

To the Editor of The Electrical World:

Sir:—In some notes on Röntgen rays I have referred to an experiment made to determine the truth in regard to the effect which it had been claimed was produced locally upon the skin and tissues of those subjected for a prolonged period to the radiation from a Crookes tube. I noted the fact that after exposing the little finger of my left hand for half an hour close to the bulb, and about 1¼ inches from the bombarded platinum, no decided effect followed until over a week; that the finger then reddened, became extremely sensitive, swollen, stiff, and, to a certain extent, painful. A slight blow or pressure would produce sharp, burning pains. I wish to add that at present about 17 days have elapsed since the exposure, and the finger is still quite sore, but showing signs of improvement. Two thirds of the exposed portion is covered by a large blister, which becomes larger each day. The pain and sensitiveness is less after the blistering takes place. The effect has not extended through the finger, but is confined to the back and sides, and is strictly limited to the exposed portion. Curiously, the skin over one of the joints of the adjoining finger, less exposed to the rays, became red and sore, but has become nearly normal without blistering, while a portion of the second finger on the side toward the source of radiation was reddened, but made only slightly sore and for but a short time only. There is evidently a point beyond which exposure cannot go without causing serious trouble. It may also be that several shorter exposures would have an equal effect if made within a few days. The effect on my finger was made in a single exposure of half an hour at short distance, and by the law of inverse squares would be the same as from 10 to 12 hours at six inches distance. I do not think that the effect is electrostatic at all, as has been suggested, a view which I was at first inclined to favor, but the effect produced on the adjoining fingers which were further from the tube than the small finger and were electrostatically shielded by it, negatives the electrostatic theory. The evidence, so far as it goes, leads me to think that the effect is another indication of the chmeical activity of Röntgen rays, of like character to the effect of the high-pitch waves of light in causing sunburn, but penetrating more deeply into the tissues. It remains to explain the long "period of incubation," which is peculiar, and is akin in effect to the well-known period of incubation in various affections due to disease germs. Here might be the place to issue a caution to experimenters—it is, do not expose *more* than a finger; be satisfied with the effect of, say, five hours' exposure at six inches' distance, and do not prolong it to equal a longer time, or there may be cause for regret when too late. Personally, I have been more than satisfied with the results of my inquiry into the action of the rays on my own tissues. Elihu Thomson.

Lynn, Mass.

Distortion of the Field by the Armature.

To the Editor of The Electrical World:

Sir:—Your issue of Nov. 20 contains an article by Mr. F. H. Sleeper on the distortion of field by armature currents, in which he advocates that the pole-piece be slotted and a compensating coil placed therein, in series with the main circuit, thus compensating for the consequent distortion of lines of force toward the leading polar horn. This device, it is claimed, if properly proportioned, will cause the sparkless point to remain stationary at all loads, and midway between the horns.

While the above is undoubtedly true, the fact still remains that the proposed device usurps the fundamental functions of the series winding usually used, as the latter is intended to increase the field excitation in consequence of the decreased permeability of the magnetic circuit, caused by the magnetization of the armature core, with increased load; the requirements for automatic regulation being the unvarying value of the magnetic flux.

The advantages of the proposed device are thus not clearly greater than a properly proportioned compound winding.

In the fifth edition of S. P. Thompson's "Dynamo-Electric Machinery," the author, on page 390, mentions the identically same idea of Mr. Sleeper as having been made by Mr. Swinburne in 1886.

Bipolar dynamos of the Thomson-Houston type have had horseshoe series-coils placed in such a manner as to be given a negative lead, and thus compensate for cross-flux of magnetic lines at full load. James A. Burnett.

Montreal, Canada.

Distortion of the Field by the Armature.

To the Editor of The Electrical World:

Sir:—I have been quite interested in Mr. Lockwood's exposition of some of the old-new things that are being brought forward in these days, in your issue of Nov. 14, page 593. The "irony of fate" curiously decreed that in the same issue there should appear a good example of an old-new thing and that you should even comment upon it, conservatively, of course, as not announcing "any new principle." I refer to the article of F. H. Sleeper on "Distortion of the Field by the Armature." If Mr. Sleeper will refer to my patent, No. 459,422, filed Oct. 31, 1885, he will see that not only is the principle not new, but the construction of the patent is the same as that suggested by him, and the construction permits compounding. I have shown in several other patents modifications in the application of the same principle. In fact, Mr. Sleeper will find, if he looks up the matter, that the "field" will have been shown to have undergone a considerable "distortion" to overcome "distortion," and that there is small chance for novelty in this regard.

Lynn Mass. Elihu Thomson.

The Berliner Patent.

To the Editor of The Electrical World:

SIR:—In an article in your last issue, Mr. E. B. Frost discusses the possible effects of a decision of the Supreme Court in favor of the Berliner patent. But in doing so he omits to consider what appears to be the most probable result of the litigation. Suppose that the Supreme Court should simply affirm the Court of Appeals. This latter court decided that there had not been such delay in the office as would vitiate the patent, disposing of the first ground of Judge Carpenter's decision. But that decision rested also on the ground that Berliner had taken out another patent for the same invention. The Court of Appeals did not decide that this was not the case, but simply held that the Government has no right to cancel its grant on that ground. In other words, the Government, like any other grantee, can recall its grant if obtained by fraud, but it cannot recall it where the officers of the Patent Office allowed the patent, in the absence of fraud, after a full investigation. For instance, the Government cannot sue to have a patent cancelled on the ground that the applicant was not the first inventor. It often happens that an applicant goes into interference with a patentee and defeats him; the commissioner then issues a patent to the applicant. The result is that there are two patents for the same invention, but the Government does not, and cannot, cancel the first one, but leaves that to be done by the courts on the motion of the later patentee. In the same way in this case, the fact that Berliner had two patents for the same invention, as he did if Judge Carpenter is right, would be a good defence to any infringement suit which the Bell Company might bring on the Berliner patent, though the Supreme Court should hold, with the Court of Appeals, that the Government cannot cancel its own grant on that ground. The decision of the Court of Appeals was a very carefully considered one, and was endorsed by the great body of attorneys familiar with such practice, but it certainly left the Berliner patent liable to a very strong attack, in view of the well-known Miller Eagle decision.

The more recent decisions of inferior courts, such as those in Thomson-Houston Electric Company *vs.* Elmira & Horseheads Railway Company, and Thomson-Houston Electric Company *vs.* Winchester Avenue Railway Company, have construed much of the life out of the Miller Eagle decision, as it was at first interpreted, but it remains to be seen how the question would be treated by the Supreme Court itself, should it again arise.

It is therefore extremely probable that the Supreme Court will render a decision which, while it will not instantly cancel the Berliner patent, will leave it in such a condition that the Bell Company cannot successfully sue on it.. ALBERT G. DAVIS.

Measuring the E. M. F. of Batteries.

To the Editor of The Electrical World:

SIR:—In the "Digest," of Sept. 26, an abstract from the London *Electrical Review*, of Sept. 4, of an article entitled "A New Method for Measuring the E. M. F. of Batteries" is given in which I note several errors.

Referring to the above diagram, it will be noticed that the two batteries are in series instead of in opposition as shown in the "Digest." Also the key K is placed between the points A and B.

To balance this network so that opening or closing the key K will not effect the galvanometer deflection, it is essential that the points A and B shall be at the same potential, a condition which would be impossible were the cells in opposition.

The thirteenth line, in the article referred to, the words, "*the same deflection*," should read, "*a constant deflection.*"

This is a very practical and convenient method for measuring the E. M. F. of a cell, as a balance can be effected with but little trouble, but its accuracy would be considerably increased by placing the galvanometer between the points A and B, as this would give a *zero deflection* on balance instead of a *constant deflection*, and can therefore be read with greater accuracy. The galvanometer also is more sensitive at that point. The second method has an advantage also in that a telephone receiver may be substituted for the galvanometer, when one is not at hand, and a very exact balance obtained in this way.

In order to test the accuracy of the two methods, I had one of our students, Mr. W. R. Bonham, measure the E. M. F. of a Gordon cell, against two of its mates, by each method.

To eliminate any errors due to a difference in the E. M. F. of the cells, three sets of readings were taken. Firstly, with cell No. 1 balanced against Nos. 2 and 3; secondly, No. 2 balanced against Nos. 1 and 3; and, thirdly, No. 3 balanced against 1 and 2.

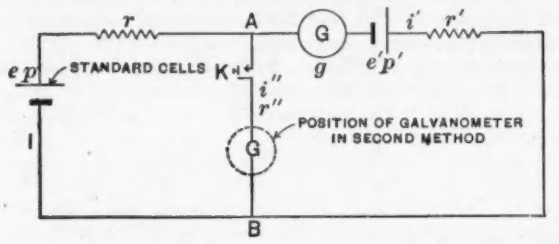
$\frac{e^1}{e}$ was then determined for each of the above cases and the average value taken and compared with $\frac{e^1}{e} = .5$, where it is assumed that the E. M. Fs. of the cells are exactly equal.

The galvanometer used was a tangent galvanometer having about 45 ohms resistance, and would detect a current of .0001 of an ampere.

Two standard resistance boxes were used for the resistances r, and r^1; and r and r^1, were made fairly large in order to check polarization.

The method used in effecting a balance was as follows:

A 200-ohm coil was cut in in the box r^1, and the resistance r was gradually increased until a balance was obtained. To make the balance exact, the key k was opened and closed at regular intervals, corresponding to the swing of the needle, so that the impulses given to the needle each time the key was closed were added. In this way an absolute balance was obtained each time. The balance was then destroyed by making r too great, and another balance was



effected by gradually decreasing r, the average of the two being taken as the true balance. r^1 was then increased by $r_1^1 = 100$ ohms, and an average balance again found as before; whence, from the equation $\frac{e^1}{e} = \frac{r_1^1}{r_1}$; the relative values of the E. M. Fs. were found. r_1 is found by taking the difference of the two *average* balances.

The following are the readings taken by the two methods:

Method I.—Cell No. 1 balanced against Nos. 2 and 3 with galvanometer in series with the main circuit.

$r^1 = 200$ ohms, $r = \left\{\begin{matrix} 520 \text{ ohms} \\ 500 \\ \hline 510 \text{ ohms} \end{matrix}\right.$ average r $\qquad$ $r^1 = 300$ ohms, $r = \left\{\begin{matrix} 720 \text{ ohms} \\ 680 \\ \hline 700 \text{ ohms} \end{matrix}\right.$ average r

$\therefore\ r_1^1 = 100$ ohms, $r_1 = 190$ ohms and $\frac{e^1}{e} = \frac{100}{190} = .5263$.

Cell No. 2 balanced against Nos. 1 and 3:

$r_1^1 = 100$, $r_1 = 210$; $\frac{e^1}{e} = \frac{100}{210} = .4762$.

Cell No. 3 balanced against Nos. 1 and 2:

$r_1^1 = 100$, $r_1 = 210$; $\frac{e^1}{e} = \frac{100}{210} = .4762$; average $\frac{e^1}{e} = .4929$.

Method II.—Cell No. 1 balanced against Nos. 2 and 3 with galvanometer between A and B:

$r^1 = 200$ ohms, $r = \left\{\begin{matrix} 430 \text{ ohms} \\ 385 \\ \hline 407.5 \text{ ohms} \end{matrix}\right.$ average r $\qquad$ $r^1 = 300$ ohms, $r = \left\{\begin{matrix} 640 \text{ ohms} \\ 570 \\ \hline 605 \text{ ohms} \end{matrix}\right.$ average r

$\therefore\ r_1^1 = 100$ ohms, $r_1 = 197.5$ ohms and $\frac{e^1}{e} = \frac{100}{197.5} = .5063$.

Cell No. 2 balanced against 1 and 3:

$r^1 = 100$, $r_1 = 200$; $\frac{e^1}{e} = \frac{100}{200} = .5$.

Cell No. 3 balanced against 1 and 2:

$r_1^1 = 100$, $r_1 = 205$; $\frac{e^1}{e} = \frac{100}{205} = .4878$; average $\frac{e'}{e} = .4980$.

Assuming the E. M. Fs. of the three cells to be equal, $\frac{e^1}{e} = .5$.

From this it will be seen that the first method is accurate only to within about .014 per cent., while the second method is accurate to within about .004 per cent. with the instruments used.

With more delicate instruments, of course, the accuracy of both methods will be increased, but that greater accuracy should increase in like proportion to the above efficiencies.

This method is not only a convenient one for determining the E. M. F. of a battery, but has the added advantage of obtaining more accurate results. J. F. COSGROVE.

CHICAGO SCHOOL OF ELECTRICITY, CHICAGO, ILL.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

DYNAMOS, MOTORS AND TRANSFORMERS.

Armature Reactions. ROTHERT. Lond. *Elec.*, Nov. 6.—A translation, nearly in full, with the illustrations of his recent paper noticed in the *Digest*, Oct. 3, and of the discussion of ZIEHL and HAAS (*Digest*, Oct. 31), and the reply of ROTHERT (*Digest*, Nov. 21).

Armature Reaction. VOGELSANG. *Elek. Zeit.*, Nov. 5.—A long illustrated communication regarding the recent articles by ROTHERT (see *Digest*, above), and by HEYLAND (see *Digest*, Oct. 24), whose statements are approved in general by him with the exception of certain points which he discusses in the present communication. He discusses first the distribution of lines of force in magnetic apparatus, showing with the aid of diagrams that in the usual magnetic disposition in alternating-current machines there is, besides the usual leakage due to magnetic shunting, another kind of "magnetic dispersion" due to the mutual action of two magnetic circuits of opposite direction; he thinks this offers a way by which the production of currents of a higher frequency, as also the changes in the wave form, may be explained. He approves of the suggestion of Rothert to combine the ampere windings by means of the parallelogram of forces, which method he thinks a very practical one, but does not see how there can be any advantage from a theoretical standpoint. The apparatus in which strong currents are used are all based on the transformation of energy by the electromagnetic counteraction of two magnetic fields; this he discusses at some length; he shows that a force can only originate by the counteraction of two magnetic fields; the energy therefore depends not only on the number of lines of force, but on their rapidity of movement; in dynamos the field is large but the speed small, while in transformers it is the opposite.

Armature Reaction in Dynamos. BRAUN. *Elek. Zeit.*, Nov. 5.—A long illustrated communication regarding the recent article by ROTHERT (see above). He thinks that the author treats the subject of armature reaction in three-phase generators too much as a special case; his results are correct for the specific case, but they do not apply to all cases in practice, which he proceeds to explain. Ziehl (see *Digest*, Oct. 31) attempted to generalize this method, but makes an error which the present author explains. He intends to discuss at some future time the general case of the armature reaction in three-phase generators and motors, with the assumption of a phase shifting and any form of wave curve.

How to Compound a Dynamo. POOLE-MCKISSICK. *Amer. Elec.*, November.—The method of Poole involves only two electrical and two mechanical measurements; the voltage across the shunt terminals is measured with the machine running under full load and giving the proper E. M. F. at the centre of distribution; then the voltage is measured when the machine is running without any load, but giving the same E. M. F. at the centre of distribution. If V is the first voltage and v the second voltage, r the resistance per 1000 feet of the shunt wire, l the average length per shunt turn in inches and C the full load of current furnished by the machine, then the total number of series turns

$$= \frac{13{,}500\ (V-v)}{r\,l\,C}.$$

The method of McKissick involves the use of a trial-coil and an independent source of current; with the field-coil in place the machine is started up and the rheostat adjusted to give the normal voltage at no load, the circuit of the trial-coil being open; full load is now added to the machine and sufficient current sent through the extra coil to bring the voltage up to the normal; the value, C, of the current in the extra coil and that in the mains, C', is noted; then the number of series turns to be added are

$$\frac{S\,C}{C'},$$

in which S is the number of turns in the trial-coil.

Generator for Three-Wire Circuits. *Elec. Eng.*, Nov. 18.—A reprint of two of the illustrations from the reports of the Berlin exposition, which have been noticed in these columns. The Lahmeyer machine described, furnishes currents for a three-wire system with a single armature and commutator; it has eight poles but they do not alternate, two neighboring ones being of like polarity and the adjoining pairs of the opposite polarity; the armature has a simple drum winding for four poles; the four brushes, connected in pairs, take off the two currents, a fifth one between two of the others representing the neutral terminal; the magnet coils corresponding to each branch are excited by currents from the other branch, by which means a better regulation is effected; the difference in the loads of the two sides may be quite considerable. The regulator for the machine is also described and illustrated, and consists of two automatically operated rheostats run by a small motor.

Automatic Transformer Cut-out. SONNEBERG. *Amer. Elec.*, November.—A description of a proposed transformer automatic cut-out. The apparatus described is rather complex, and a battery is required to supply current as long as the circuits are open.

Faults in Regulators. *Amer. Elec.*, November.—A description of the new Brush arc light regulator and its operation, with an enumeration of the faults to which it is subject and methods for their correction.

LIGHTS AND LIGHTING.

Standardizing Incandescent Lamps. *Elek. Zeit.*, Nov. 5.—A reprint of the propositions of a committee appointed to the German Union of Electricians, in which committee both the manufacturers and consumers are represented. They refer to lamps of 60 to 70 and 95 to 125 volts, with a consumption of 3 to 4 minutes per candle (Hefner unit) and of 10, 16, 25 and 32 candle-power. The lamps are to be marked with a voltage which corresponds to the candle-power, which should also be marked; a variation of 2 per cent. above or below the voltage stated in the order is to be permissible; the lamps are to be tested at the voltage marked thereon; a variation of 6 per cent. above or below in the candle-power and energy consumption is permissible; if more than one quarter of the lamps tested exceed these limits the whole shipment may be returned. The useful life of the lamp is to be taken as a measure of the life; under the useful life is understood to be the number of hours before the lamp, at its indicated voltage loses 20 per cent. of its candle-power; the mean useful life will be stated by the manufacturers. The next section refers to the way in which the photometric measurements are to be made, but this is omitted as it seems that it has not yet been determined. Any complaints regarding the batch of lamps must be made within 30 days after they are received and then only if there are still 2 per cent. and at least 20 lamps left to be tested. Any disputes regarding the tests are to be submitted to the Reichsanstalt whose decision is to be final, the cost of the same to be borne by the one against whom the decision is. The committee recommends the Edison screw-socket for universal use. A copy of the guarantee is given, which manufacturers will give to the purchaser for an order of at least 1000; it is merely a formal statement of the above.

Tower Wagon for Arc Lamp Trimmers. *West. Elec.*, Nov. 21.—An illustrated description of what is believed to be the first of its kind in this country; it is used for trimming the 750 lamps in the parks and boulevards of Chicago.

POWER AND HEAT.

Eichdorf-Gruenberg Power Transmission Plant. KLUG. *Elec. Zeit.*, Nov. 5.—A long description of this high-voltage transmission plant, which has been running for some time and is the second one in Germany in which 10,000 volts are used; the distance is 25 km (15 miles); the three-phase current is used; the motive power is partly water-power; the current is transformed up from 250 to 10,000 volts at the generating end by two transformers of 100 and one of 55 kw. Much stress is laid on the arrangement of the lines, the description of which is quite a long one. The lightning arresters on the poles are of the form described in the *Digest*, Sept. 5, consisting merely of two bent wires supported on two insulators; beside this there is a barbed wire along the top of the poles, which is grounded at frequent intervals; the lightning arresters have proved to be very satisfactory (their simplicity certainly leaves little to be desired). The overhead line consists of bare wire on porcelain insulators; careful precautions are taken against the breaking of any of the wires and against their coming in contact with other overhead wires, there being guard wires above and a sort of grounded network below them; the step-down transformers are contained in ornamental street boxes. A test was made to find whether there is any danger to firemen and for this purpose a stream of water from a hose was directed across two of the wires so as to touch both of them; neither a short circuit through the water nor even a small deflection in the voltage indicator could be noticed; a similar experiment is cited with 8000 volts which gave the same results and in this the metallic nozzle of the hose was held by the fireman.

Reducing Gear for Electric Motors. Lond. *Elec.*, Nov. 6.—An illustrated description of an ingenious arrangement devised by Ross, which is being

used with electric motors for drills. The advantages over the ordinary gearing are that the driving and driven shafts are in the same line, that the gear is contained compactly within an extension of the motor case, and that high ratios of speed reduction are obtained with gear wheels of small differences of diameter; it is also claimed that this gear is more efficient than a worm gear. An annular gear wheel is fixed to the motor case and is concentric with the motor shaft; the end of the motor shaft is provided with an overhung crank, the pin of which carries two spur wheels secured together, the smaller one gearing into the annular wheel above mentioned, while the larger one gears into a second annular wheel which is keyed directly to the low-speed shaft; the difference in the diameters of the wheels in each pair is exactly equal to the complete throw of the crank, which latter is balanced to prevent vibrations.

Electric Furnaces. BORCHERS. *Zeit. f. Electrochemie*, Nov. 5.—The beginning of an illustrated article on electric furnaces for metallurgical purposes, in which he intends to describe their development and the conditions governing their construction and operation; the present portion refers to those in which the heat is generated by resistance, as distinguished from those in which it is generated by the arc.

Calcium Carbide Furnace. Zeit. f. Electrochemie, Nov. 5.—A description of a furnace devised by TENNER, the distinguishing feature of which appears to be that the bottom is on rollers and can be drawn out when the reaction is complete.

Niagara-New York Power Transmission. Elec. Eng., Nov. 18.—An abstract of Stilwell's report regarding the recent transmission at the New York Electrical Exhibition, taken from the report of the National Electric Light Association. A two-phase current with a frequency of 25 and a voltage of 2200 was taken from one of the Niagara Falls alternators and transformed down to 500 volts, at which it was transmitted at a three-phase current, one of the three circuits being the ground and the other two telegraph wires. The transformers at New York delivered 14 watts each, the magnetization energy being less than 1.5 watts and that lost in the copper 0.25 watts; the energy required by the motor was 8 watts; no very accurate measurements of the power were taken; but in dry, favorable weather it was probably one thirtieth of a horse-power; the motor was of the induction type and wound for two-phase currents, the currents being transformed by the Scott system to a two-phase current at 8 volts, although the latter varied between rather wide limits, depending largely on the leakage of the lines.

Gas and Oil Engines for Electrical Generation. Amer. Elec., November.—An article descriptive of the principal gas and oil engines manufactured in the United States, 12 of which are illustrated. An editorial commenting upon the article states that the working or machine efficiency of a gas engine is about the same as that of the steam engine; tests have shown that the ratio of the heat transformed into work and the entire heat available for work may be as high as 67 per cent., notwithstanding the loss of heat in the water jacket and that due to the considerable temperature of the exhaust. Owing to the upper limit of temperature in the gas engine being fixed by dissociation, improvements in gas engines are limited to reducing the losses in the water jacket and exhaust; it is editorially stated that a consumption of 17 cubic feet of gas per hour, corresponding to about three-quarters of a pound of combustible, may be accepted as forming quite the best performance that may be expected from a gas engine.

Carbon and Thermo-Batteries. E. THOMSON; REED. *Jour. Frank. Inst.*, November.—A discussion of a recent paper by Reed on the Jacques carbon battery and the Reed thermo-tropic battery. Reed's descriptions of his experiments and apparatus regarding these two batteries have already appeared in the THE ELECTRICAL WORLD pages, July 25, p. 98, and Aug. 8, p. 159. In the discussion Thomson stated that his observations with the Jacques all tended to show that the air introduced has for its function the formation of a film of oxide on the iron cell, which during the action is continually reduced to metal, possibly by nascent sodium; carbon in the presence of hot melted sodium hydrate tends to reduce it, liberating the sodium; at a lower temperature there may be formed a polarized molecule chain, which by the oxidation of carbon sets free sodium ions, reducing the iron oxide which is continually forming from the oxygen of the air. Referring to the thermo-tropic battery of Reed, he expresses the belief that the effects are essentially thermo-electric, the film of oxide representing an exceedingly short element, the junction of which with the hot copper on the one side is much higher in temperature than the other junction. Many years ago he noticed similar effects; on touching a cold piece of zinc with a copper which had been scaled and which was still hot, a strong deflection in the galvanometer was obtained by connecting the two metals, the deflection being much greater than when the metals were used in the usual way as a thermo-junction. In the present form the length of the badly conducting elements has been greatly reduced; he suggests that the thermo-electric principal may possibly in this way reach a practical development. In reply, Reed stated that Thomson's suggestions regarding the Jacques battery are very instructive; whatever be the origin of the current it must cause a reduction of some constituent at the cell wall; if the electrolyte is sodium hydrate the only possible reduction products are hydrogen and sodium, either of which reduces the iron oxide; he thinks, however, that there is a more probable explanation of the reduction of the iron; alkaline hydrates at that temperature oxidize iron, forming alkaline ferrates, from which the iron would be reduced directly by the current more easily than either hydrogen or the alkaline metal, he therefore believes that there is a reduction of iron rather than of sodium, which is partly true if the reduction is not electrolytic, but by contact with hot carbon; a more suitable electrolyte might therefore be found in salts, as the alkaline arsenates, bismuthites, etc., most of which are capable of reduction by forming a lower oxide and without reducing a metal to the free state. He agrees with Thomson that the thermo-tropic junction is only a species of thermo-electric junction, in which one metal is replaced by an electrolyte; fused and solid electrolytes may have an enormous thermo-electric power, the cold wire acting merely as a conductor. Regarding the hope of such thermo-electric batteries, he believes that the most serious defect of galvanic batteries will also be found in this, namely, that the evolution of electric energy depends upon and is commensurate with the mechanical destruction of the apparatus itself, the cost of renewing which is always greater than the cost of the fuel.

TRACTION.

Lausanne Electric Railway. Lond. *Elec.*, Nov. 6.—A brief description of this recently opened railway which possesses some unusual features. The total length is 7.5 miles and the maximum grade 11.3 per cent., which is said to be the greatest in Europe; the line is very hilly; each car has two motors of 20 horse-power each, the cars seating 26 passengers; the motive power is obtained from gas engines directly coupled with six-pole dynamos; the reserve dynamo is in parallel with a large battery of accumulators.

Proposed Deep-Tunnel Railway in London. Lond. *Elec.*, Nov. 6.—A short note stating that an announcement has been made that a deep-tunnel electric railway between Hammersmith and Cannon Street station in London is projected, the total length being about six miles; there will be two tunnels; the cars will seat 48 passengers; the cost is estimated to be about $2,500,000 per mile; the system of electric traction to be adopted will be decided upon later.

Budapest Subway Railway. KOLLMANN. Lond. *Elec.*, Nov. 6.—A translation from the German of a description, without illustrations, of this new railway which was built only for the exhibition but will probably remain in use; it is stated that it is already certain that the road will be profitable.

Repair of Street Railway Apparatus. Amer. Elec., November.—Methods of wiring the lamps and heaters of electric railway cars are discussed; circuits are described whereby in addition to the usual incandescent lamps for lighting a trolley car, others may be installed for emergency uses. A method is also given for utilizing in the winter the controller resistance or "diverter" for heating the cars.

Jungfrau Mountain Railway. Elec. Eng., Nov. 18.—An abstract of the article noticed in the *Digest* last week, including some maps of the roads and illustrations of the scenery.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Croydon. Lond. *Elec. Rev.* and *Elec. Eng.*, Nov. 6.—An illustrated description of this station, the latter journal containing many more illustrations than the former. It was constructed by the Thomson-Houston Company, which will run it for five years, guaranteeing interest on the capital and sinking fund, after which it is to be a municipal station. It contains three direct-driven alternators of 120 kilowatts in addition to which there is a motor alternator the continuous current from which is used for charging accumulators for exciting the field magnets and for carrying the whole load at times of light load and on Sundays by driving the alternating-current motor as a generator; the concentric system of mains is used; there is a small booster running from the battery furnishing a current at 2 to 10 volts for charging faulty cells, thus dispensing with "hospital cells." There are four transformer stations which are thoroughly interconnected; there are about 50 arc lamps for public lighting which are fed with rectified currents on a separate circuit.

Bury. Lond. *Elec. Eng.*, Nov. 6.—A long, well-illustrated description of this station, in which continuous-current, direct-coupled dynamos are used, with a three-wire system, the dynamos being capable of having their voltage increased sufficiently to charge the accumulators. The results of some tests of the engines and dynamos are given.

Rebate Indicator. WRIGHT system. Lond. *Elec. Rev.*, Nov. 6.—A long, illustrated description of the improved form of the instrument as now manufactured, with an explanation of the way it is used; it is said to embody important improvements. The U-shaped tube is provided with an additional limb into which the liquid overflows, thus simplifying the resetting of the instrument. The object of the instrument is to show the maximum current that has been taken since the date at which it was last read, thus enabling one to determine the proportion of the plant which has been kept in readiness to supply that customer; it is in extended use and is satisfactory in every respect with the exception that it is difficult to convince the non-technical consumer that a benefit is conferred on him by

the practice of charging directly as the demand and inversely as the consumption.

Isolated Lighting Installations. Hasson, Bernard, Barnett. *Amer. Elec.*, November.—Three articles on the details of isolated lighting installations for country residences. The article of Hasson describes a plant installed at the residence of Mrs. Senator Hearst, Sunol, Cal.; the plant consists of a 9-kw dynamo and 60 chloride storage cells; the dynamo is driven by a twin cylinder gasoline engine belted to a ratchet pulley on a countershaft, the dynamo being run from the latter. The plant described by Bernard consists of an 8-kw dynamo direct connected to a Case engine running at 550 r. p. m., and a chloride storage battery of 42 cells of 500 ampere hours capacity; the lamps are connected on two separate circuits, both of which are ordinarily run from the storage battery, but on special occasions are separated, one being run from the storage battery and the other direct from the dynamo. The article of Barnett treats in a general way of electric plants for country residences and lays down the considerations which should be observed in their design; the article also contains detailed information on the care and management of storage batteries.

Acid Joints; Electrolytic Corrosion. Rand. *Amer. Elec.*, November.—A case is described where the lamps on a dynamo-circuit refused to light up, although the pilot lamp at the dynamo burned at normal candle-power; it was found that one of the dynamo-leads was loose in its lug, which was hot, and that a layer of fine white powder had prevented contact. Another case is related where lamps on part of a circuit refused to light, and upon investigation it was found that one of the mains had been corroded nearly through by electrolysis. The ends of the wire when taken out are said to have had a point as fine as a needle. A leak had kept the moulding damp, which had produced electrolysis.

WIRES, WIRING AND CONDUITS.

Interior Wiring. Amer. Elec., November.—The three-wire system and its modifications are treated in the current installment of this serial.

ELECTRO-PHYSICS AND MAGNETISM.

Wave-Length of Röntgen Rays. Fomm. Lond. *Elec.*, Nov. 6.—A translation of the complete article noticed in the *Digest* last week.

Trevelyan Rockers. Appleyard. Lond. *Elec.* and *Elec. Eng.*, Nov. 6.—A brief notice of an exhibition before the Physical Society. He describes a number of different forms, the most interesting of which consists of two rods of carbon fixed to a wooden sounding-board, with a third one across them, forming a microphone, through which a strong current passed in series with two magnets acting on a tuning fork fixed to the sounding board.

Dilute Ferro-Magnetic Amalgams. Nagaoka. *Elek. Zeit.*, Nov. 5; abstracted from *Wied. Ann.*, Vol. 59, page 66.—He made experiments and gives the curves for amalgams of iron and cobalt containing only 0.19 to 2 per cent. of iron or cobalt, the amalgams being prepared by depositing the magnetic metal electrolytically onto mercury.

Thermocells of Amalgams and Electrolytes. Hagenbach. *Wied. Ann.*, Vol. 58, p. 21; abstracted in the *Zeit. f. Electrochemie*, Nov. 5.—He describes researches to prove the theory of Nernst; his results show the decrease in the thermal power with increasing dilution, as required by the theory, but the quantitative results were always much less than the theoretical.

Notes on Röntgen Rays. E. Thomson. *Elec. Eng.*, Nov. 18, and *West. Elec.*, Nov. 21.—He calls attention to the fact that there is a dividing plane coincident with the platinum sheet, on one side of which the tube is fluorescent, while on the other it is dark, the division being very sharp and the intensity of the radiation being sensibly the same whether the rays emanate normally or at an angle, as was shown by measurement, but the focusing effect is more sharp for the rays leaving at high angles to the normal, that is, nearly in the plane of the sheet, a fact which may be taken advantage of when necessary; from this he concludes that the fluorescence on the glass is caused by and is an index of the intensity and distribution of the rays; there is a question whether, when the glass is bombarded by the cathode rays, the fluorescence produced is the direct result or whether it arises from the Röntgen rays which are the result of such bombardment; sometimes sparks one eighth of an inch long can be drawn from the tube at the fluorescing spot; recent observations show a change in polarity, the bombarded spot being negative while the other parts are positive. To test the question some of the same glass was finely powdered and secured to a screen, when it was found to give a feeble result; he believes that the radiation which reached the glass screen must have lost enormously in passing through the glass wall of the tube; it is known that the glass wall is too thin to absorb the Röntgen radiation to any great extent; he suggests therefore that the rays which are produced at the platinum surface may be mixed with others of a lower wave length, which, while they can excite fluorescence of the glass as much, if not more than the Röntgen rays, are absorbed by the glass wall; it has been shown theoretically that such rays can exist and have this property; considering Röntgen rays to be rapid transverse vibrations, the bombardments may give rise to other rays too low in their rate to penetrate such materials as are used for the tubes. To test the effect of Röntgen rays on the skin he exposed one of his fingers for half an hour to the radiation of a strongly excited tube; no noticeable effect was produced for several days, but eleven days afterward the finger became red and swollen, and began to blister, the effect resembling a strong sunburn; this leaves room for the hope that these rays may be found to have a therapeutic value, but it is doubtful if they can be superior to the ordinary violet rays, except in the power to penetrate opaque bodies.

Röntgen-Ray Observations. Edison. *Elec. Eng.*, Nov. 18.—A list of the chemical crystals which fluoresce with Röntgen rays and forming an addition to the list of 72 others already published by him; his experiments are claimed to cover every chemical substance sold commercially. It appears that the double salt of silver and sodium chloride fluoresces, and as this substance occurs in the plates, he thinks the sensitiveness could be increased by adding definite amounts. None of the substances given in the long list are as sensitive as calcium tungstate; defective crystallization and impurities reduce the sensitiveness of this salt more than 50 per cent., while certain crystalline forms of it do not fluoresce at all. He adds that Röntgen rays have a powerful effect on the moral condition of vision and that with strong tubes one can easily see through the hand with the naked eye when both are brought very close to the tube; for the first two or three seconds the eye perceives nothing, but after that some changes occur in the eye and the sensitiveness is increased.

Effect on the Skin of Exposure to Röntgen Rays. Stine. *Elec. Rev.*, Nov. 18.—A brief account of a clear case of the burns and inflammations resulting from a long exposure to Röntgen rays. The patient had been exposed to the tube for about two hours each of two consecutive days; the skin turned a dark brown color, and after a few days grew very red and inflamed, but there were no blisters; the whole resembled a bad sunburn. He concludes that the effects are not due to the X-rays but rather to the ultra-violet rays, which are always present to a greater or less extent; they result only from the focusing tubes; when pear-shaped tubes are used no burns seem to result from even long exposures to powerful tubes.

Inductance of Magnets. Amer. Elec., November.—In the current installment of the serial on "Lessons in Practical Electricity," the subject of inductance is considered and its effect on the working of the telegraph and other magnets shown. The deduction is made that if the external resistance in the circuit of such a magnet is small in comparison to the resistance of the magnet itself, then increasing the number of turns in that magnet, its strength remaining the same, will not practically affect its working; if, however, the external non-inductive resistance is considerable with respect to the resistance of the magnet, then increasing the number of turns of the latter will make it slower working, the strength of the magnet remaining the same. Any magnet may be made quicker working by putting non-inductive resistance in the external circuit, the strength of the magnet being kept the same by increasing the E. M. F.

ELECTRO-CHEMISTRY AND BATTERIES.

Generation of Electricity by Chemical Means. Andreas. *Zeit. f. Electrochemie*, Nov. 5.—He does not consider that such generation of electricity in large quantities is hopeless, and makes a suggestion in this direction. One of the chief requirements is to abandon electrodes which are consumed and to replace them by such on which oxidation of hydrogen, carbon monoxide, etc., takes place without the solution of the electrode itself. The chief reason for the failure of Borcher's battery is that he used metallic electrodes which were dissolved, carbon monoxide taking absolutely no part in the reaction; he made extended researches with this cell in 1895 and gives the results briefly; he obtained no oxidation of the gas, not even when he used metallic electrodes which are not attacked nor when heat was applied. He then suggests a new form of the Grove gas battery with which he obtained quite good results; he considers that the principal requirement is to have a large surface of contact between the electrolyte, the electrode and the polarizer, which therefore means that the electrode should be porous; he used a net of platinum wire on which was laid some filter paper saturated with an electrolyte and on this a second net; this answers the requirements; with this he obtained quite strong currents with illuminating gas and air, oxygen and hydrogen, and with hydrogen and chlorine, in the latter case one ampere at 1.5 volts difference of potential with a pressure of about three atmospheres; the platinum for a single element cost about $5 and he therefore decided to use carbon. In Borcher's cells with carbon electrode and a constant current, 0.6 ampere was obtained as long as the copper solution was not completely oxidized, and the problem therefore is to keep reducing the copper solution, which cannot be done by means of carbon monoxide but is very easy with sulphurous acid, while the chlorine may well be replaced by atmospheric air; this form might be developed into a practical cell, as the prime cost and cost of materials are very small, but the fault lies with the final products which are sulphuric acid mixed with hydrochloric acid and chloride of copper, and the cost of separating this mixture must be considered. If sulphurous acid is passed through dilute sulphuric acid with chlorine or oxygen as the other gas, and used

as depolarizers with carbon electrodes, the action is much less intense as with the chemical combination of these gases with the copper salt solution, but nevertheless a favorable result is possible when higher pressures are used; he thus obtained with two carbon tubes, and with chlorine in the one and sulphurous acid in the other, 0.5 volt with 1 ohm resistance; with this the product is sulphuric acid and hydrochloric acid, but he believes that with the use of large electrodes practical results can be obtained with air, as the final product is then only sulphuric acid, which has a commercial value; the dimensions of his electrodes were only 160 mm by 35 mm in diameter.

Gas Cell. BUCHERER system. *Zeit. f. Electrochemie*, Nov. 5.—An illustrated description of a cell patented in Germany. It consists of a wrought-iron vessel which contains a fused mixture of sodium and potassium carbonate; the electrodes are made of hollow tubes closed at one end and connected at the other with tanks containing the gases; the cathode is of platinum, which absorbs oxygen, and the anode is of cast iron or nickel, which absorbs carbon monoxide at a red heat; one of the gases is oxygen and the other carbon monoxide; a smaller amount of coal is said to be required for the heating of a vessel than would be used for driving a dynamo by means of a steam engine; the electrolyte remains unaltered. Instead of passing oxygen through the porous tube a metallic peroxide in contact with the liquid may be used; it forms a means of taking the oxygen out of the air and bringing it into the electrolyte. Regarding the efficiency he states merely that it is not as high as it would be for liquid electrolytes at the ordinary temperature.

Apparatus for Gas Reactions. NAVILLE and GUYE. *Zeit. f. Electrochemie*, Nov. 5.—They propose to overcome the objections to the usual eudiometer, in which the products which are produced are often again decomposed; in the present apparatus the gas on which the electric spark acts is quickly renewed and the products formed are led off, while at the same time the gases are forced to pass through a small aperture in which the spark is produced; various forms of the apparatus are described and illustrated, the underlying principle being that the gases pass in a fine stream directly through a contracted space where the spark occurs.

Porous Carbon Cylinders in Electrolytic Researches. LOEB. *Zeit. f. Elektrochemie*, Nov. 5.—He discusses the action of a porous carbon cylinder under various conditions, illustrated with numerous experiments showing the difference between it and a non-conducting porous cylinder. The resistance even in distilled water is negligibly small; they therefore act as intermediate conductors (Mittelleiter) and electrolysis will take place on both sides of them; when used as an electrode with the other electrode outside of it, there will always be some decomposition inside of the cylinder, an observation which was made by Bunsen; he illustrates this with an experiment in which a cylinder is placed in sulphuric acid with an external platinum electrode, the cylinder being filled with copper sulphate; some gas will be generated on the outside of the carbon, and metallic copper will be deposited on the inside; other experiments are also described. His conclusions are that a porous carbon cylinder in place of one made of a non-conductor has the functions of a diaphragm and of a metallic intermediate conductor; when used directly as a cathode (or anode) the whole surface inside as well as outside will be a cathode or (anode); the separation of the ions on the inside and outside will depend on their combining forces; if the cathode (or anode) is metallically connected with the carbon cylinder so that both have the same potential, they will both act as a cathode (or anode) of an enlarged surface.

Metallurgy of Silver and Gold. NETTO. *Zeit. f. Electrochemie*, Nov. 5.—A brief description of a process for making the cyanides active again after the metals have been extracted. The solution containing gold and silver is mixed with hydrochloric acid until it is slightly acid; this deposits the silver as a precipitate, leaving the gold in solution; it is then electrolyzed, care being taken to have sufficient hydrochloric acid in the solution; after this it is mixed with sufficient caustic alkalies until it is slightly alkaline; it is then in a condition to be used over again for the extraction of more metal.

Cyanides from Carbides. CARO. *Zeit. f. Electrochemie*, Nov. 5.—Cyanides can be prepared from the carbides made in an electrolytic furnace if nitrogen at not too high a temperature (about at red heat) is passed over the carbides in the presence of steam, the whole being in a closed vessel. The cyanides can be prepared directly if the carbides of the alkaline earths mixed with alkalies are treated with steam and nitrogen when heated; the process can also be used for making ferrocyanides when the carbide is mixed with finely divided metallic iron or a combination of iron with alkalies, and acted on by a current of nitrogen and steam at a high temperature. Several examples showing the application of this method are given.

Sulphide of Aluminum. Zeit. f. Electrochemie, Nov. 5.—A description of the PENIAKOFF method of preparation.

Electrolysis at Low Voltage. RICHARZ and LONNES. *Zeit. f. Phys. Chem.*, Oct. 20; noticed briefly in the Lond. *Elec.*, Nov. 6.—Sokolow some time ago proved that water could be electrolyzed by any E. M. F., however small, and believed that the absence of visible decomposition was due to the absorption of the gases by the electrodes; the present authors point out the probable formation of hydrogen peroxide by molecular oxygen; this was formed at a gold, palladium or platinum cathode immersed in a 1 per cent. solution of sulphuric acid, when the voltage was that of one Daniell cell, but not less.

Electrolytic Theories. BUCHERER. *Zeit. f. Electrochemie*, Nov. 5.—A reply to a recent unfavorable criticism in that journal of this theory (see *Digest*, Oct. 3 and June 6); in this criticism an incorrect interpretation of the theory is given and in the present communication he corrects this. It is followed by a reply by Danneel.

Theory of Electrolysis. TOWER. *Zeit. f. Phys. Chem.*, No. 20; noticed in the Lond. *Elec.*, Nov. 6.—He compared the differences of potential between various acids and salt solutions with the figures given by the theories of Nernst and Planck, showing a close agreement.

Theory of Liquid Chains. LOVEN. *Zeit. f. Chem.*, 20, page 593; abstracted in the *Zeit. f. Electrochemie*, Nov. 5.—He develops the theory of liquid chains, to include electrolytes with ions of different valency, when the solutions are "isomotic" with reference to the ions dissolved in them.

Electrolytic Refining of Copper. ULKE. *Eng. & Min. Jour.*, Nov. 14.—A brief summary of recent improvements, referring chiefly to some recent patents, and including an illustrated description of a method of circulation which is used in a refinery at Perth Amboy, consisting merely of a perforated tube at the bottom and at the top of the tank, the liquid being sucked up from the one and passed out through the other by means of an air lift.

Cyanide Patent Decision. Eng. & Min. Jour., Nov. 14.—An editorial discussion of the recent decision regarding the McArthur-Forest patent. The same issue contains a short history of the cyanide patents.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Measuring Electrolytic Conductivity. STROUD and HENDERSON. Lond. *Elec.* and *Elec. Eng.*, Nov. 6; a brief abstract of a Physical Society paper.—They describe what they call a satisfactory method of measuring electrolytic conductivity by means of a continuous current. The method consists in placing a balancing electrolytic cell in the arm of the Wheatstone's bridge adjacent to the arm containing the chief electrolytic cell, so that the E. M. F. of polarization in the two cells neutralize each other's effect on the galvanometer. The authors find that if the resistance of the arms of the bridge are high (20,000 ohms), and if an E. M. F. of about 30 volts is used in the battery circuit, then the resistance of a solution (of potassium chlorate in their experiments) can be determined to within about one part in 2000. With a D'Arsonval galvanometer the balancing cell is so efficacious that it is impossible to tell that it is not a metallic resistance that is being measured. In the discussion Prof. Perry asked whether they found the difference in resistance of the two cells to be proportional to the difference in length of the liquid columns. Appleyard found that the resistance appeared to vary in the ordinary arrangement because the cell was short circuited through the bridge, and suggested as a remedy making and breaking the circuit by a key, so that the cell is on open circuit except when a reading is taken. Blakesley asked if they had tried the method in which the resistances are adjusted until there is no immediate change in the deflection when the battery circuit is broken; it is possible thus to measure a resistance between 6000 to 10,000 ohms to within 0.1 per cent. Ayrton said this latter method was the ordinary false zero method, but in the method under discussion the zero was constant. Appleyard had found the false zero method troublesome. Stroud in reply stated that they had not tested the proportionality between the resistance and length.

Measuring the Voltage of Accumulators. HOPFELT. *Zeit f. Electrochemie*, Nov. 5.—An illustrated description of a device for measuring the E. M. F. of an accumulator at the end of a discharge or charge, independently of the current which may be passing through it at the time; this is accomplished by making this current act on the same needle in the measuring instrument in such a way as to eliminate its effect on the voltage; it is stated that the moment when the accumulator is completely charged can then be very readily observed. The instrument is a sort of differential galvanometer having two coils, one of which is a regular voltmeter coil, and is connected directly to the terminals of the battery, in series with the necessary resistance, while the other coil is connected in parallel to a resistance in the main circuit, or it may be an ordinary series coil; the latter should be so connected that its action is in the same direction as that of the other coil when the battery is discharging; the deflection will therefore correspond to the sum of the two sections while discharging and to the indifference while charging. With this instrument there is said to be a sudden rise and fall in the voltage at the completion of the charge or discharge, while during the rest of the time it is said to give a nearly constant reading which is independent of the current.

Localization of Faults in Electric Light Mains. RAPHAEL. Lond. *Elec.*, Nov. 6; the conclusion of his long serial.—He describes the construction of the indicators which are used in Berlin according to the Agthe and the Kallmann methods; a long illustrated description is given, which does not admit of being abstracted; it requires the use of special test wires and is said to work admirably. Kallmann devised a modification in which only a few volts are required between the cable and the test wire, but in

is not considered preferable to the other. He also devised another way of connecting a system of test wires to form a fault signalling network, which is also used in Berlin, and is applicable to nearly any system of mains; the principle is to measure automatically any increase in the potential of the earth at various points of the supply area, but it appears that it cannot be used in a district where there are electric tramways.

Photographic Photometers. Simon. *Elek. Zeit.*, Nov. 5; abstracted from *Wied. Ann.*, Vol. 59, page 91, including the illustration of the apparatus.—He makes a photographic print with the light to be measured, which therefore forms a record and he compares this with a record of a known source; the record contains two bands next to each other, one of which is of a uniform tint, while the other varies from one end to the other. The measurement then consists in finding the point at which both bands have the same intensity; for the latter operation an apparatus devised by Zeiss is used, consisting of prisms and lenses through which the images are seen as two semi-circles next to each other, and the bands are moved until these two semicircles have the same tint. He also explains its application to the photometry of the rays in the ultra-violet spectrum and shows how the wave length of the light may be determined by this method.

Voltmeter Measurement of Insulation Resistance. Corson. *Amer. Elec.*, November.—A method for measuring the resistance insulation between the ground and a system of wiring, or of a dynamo or other translating device while the system is in operation; the only instrument employed is a voltmeter.

Wimshurst Influence Machine. Amer. Elec., November.—Instructions accompanied by detail drawings, for making a static machine of the Wimshurst type. The article states that the entire cost of the making of the machine described should not exceed $5.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telegraph Statistics for Germany. Elek. Zeit., Oct. 29.—A brief extract from the official report for the five years 1891–1895. Up to March 31, 1895, the number of government telegraph stations in the territory covered by the Post Office Department was 13,729, the length of the telegraph lines 119,539 kilometres, and the length of the circuits 547,814 kilometres; this represents an average increase of one telegraph station a day, 14.5 kilometres of lines and 95 kilometres of wire per day. The number of telephone stations is 449, an increase of 211 in the five years; the number of subscribers is 103,633 as compared with 52,405; the most marked development was in the interurban lines, which five years ago comprised only 17,163 kilometres, while now they are 59,532 kilometres in length.

Belgian Telegraph Jubilee. Lond. *Elec. Rev.*, Oct. 30.—A reprint of the address of Banneux (noticed in the *Digest* last week).

The Berliner Patent Suit. Amer. Elec., November.—A review of the history of the suit and a synopsis of the points contained in the briefs of several Government counsel. The same suit is the subject of editorial comment.

New Enclosed Arc Lamp.

The lamp illustrated herewith is of the enclosed arc long burning type,

Fig. 1.—Enclosed Arc Lamp.

Fig. 2.—Globe Lowered for Trimming.

Fig. 3.—Globe and Casing Removed.

for use on direct-current incandescent circuits, and embodies several distinctive features. It has recently been put on the market by the Perkins Electric Switch Manufacturing Company, Hartford, Conn.

The points aimed at in the construction of this lamp are simplicity, entire absence of delicately adjusted parts, and easy adaption to circuits of different voltages.

The arc-striking and feeding system is composed of two series solenoids, to whose core connecting yoke is secured one end of an elongated plain washer clutch by means of a short link. The action of this simple clutch is made reliable by means of a small, weak dash-pot attached to its forward end.

The globe holder is the subject of an invention that has been applied to lamps manufactured by this company for some time past.

A feature worthy of note is the method of re-trimming the lamp. The lower carbon is held in a chuck, which also holds the outer globe in position. The upper carbon is put through the opening in the outer globe while it hangs in its lower position, after which the chuck with its lower carbon is raised and secured, carrying the outer globe with it. Another feature is the short-circuiting clip in the resistance, which is mounted on a triple-thread screw, and is operated by means of a key which is accessible without disturbing the ornamentation.

All the working parts of the lamp may be brought to view at any time without unhanging it.

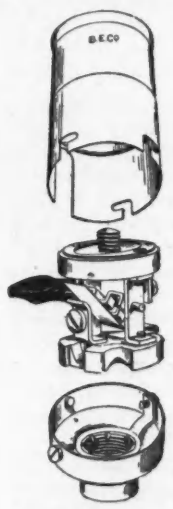
Mr. Gilbert L. Moyer, the electrician of the Perkins Electric Switch Manufacturing Company, is the inventor of the lamp.

The cuts illustrate the standard plain lamp, which maintains an 80-volt arc with a current of four amperes.

Key Socket.

A very valuable though simple improvement and one deserving special attention, is that recently made in the key socket by the Bryant Electric Company, Bridgeport, Conn.

Users of sockets, especially the fixture men, have experienced more or less annoyance through the failure of the socket to retain its correct position on the fixture after adding to it the weight of a heavy shade and lamp. While the two screws holding the shell to the cap do all that can be expected of them, they generally act as a pivot, permitting the shade to sag downward, giving it an unsymmetrical effect and absolutely ruining the appearance of what would otherwise be a handsome fixture. The improvement made by the Bryant Electric Company lies in the third bayonet joint in the shell and the stud in the cap. The bayonet-joint opening being wedge-shaped and the stud having a flat head, it can be readily seen that the shell when turned into place becomes firmly locked, holding the socket, shade and lamp perfectly rigid.



Key Socket.

This style of socket is designated by the Bryant Company as No. 2-B, and the goods are now in the hands of the jobbing trade.

Adjustable Incandescent Lamp Holder.

The accompanying illustrations show two styles of adjustable holders for incandescent lamps, manufactured by the O. C. White Company, Worcester, Mass.

Appreciating the troubles which restricted the use of the incandescent lamp, especially in factories and machine-shops, the O. C. White Company some three years ago placed upon the market several styles of adjustable holders. By means of these devices the lamp could at once be placed in any conceivable position throughout a great range. The efforts of the O. C. White Company were readily appreciated, a large number of leading concerns at once installing these holders.

The O. C. White Company continued to add to and improve upon the original patterns of its holders until at the present time it has a variety

New Wall Bracket.

which, in styles, sizes and finish, are adapted to every requirement from library to work-shop. The holders are entirely automatic in their adjustment, that is, no attention whatever is required by the joints when

placing the lamp in the desired position. The frictional joints are given the desired tension by an ingenious application of the spring washer and there is hardly the slightest chance of their getting out of order.

Recently a number of new styles of holders have been placed on the market by the O. C. White Company. They are designed to secure an extreme range of adjustability and a perfect protection for the conducting cord, combined in a serviceable and graceful manner. The methods employed are said to be decided novelties in mechanics, the main features of which are simplicity, durability and instant adjustment and fixation.

A great many of the leading manufacturing establishments and offices of the country are now equipped with these holders.

New High-Frequency Induction Motors.

The new single-phase and three-phase high-frequency induction motors of the General Electric Company have been designed to operate from circuits of 125 cycles, and to run at any frequency within 10 per cent. greater or less than 125 cycles with corresponding increase or decrease in the speed.

Two lines of motors have been designed—those for three-phase circuits and those for single-phase. The mechanical structure and electrical features of the standard G. E. 60-cycle induction motors also distinguish these. The armature of induced element, in all sizes larger than 5 horse-power, has a polar winding and a revolving starting resistance cut out by means of a lever. In the 5 horse-power size and less the armature either has the polar winding and starting resistance or is built with individual short-circuited coils. While the latter is cheaper, the starting current required is greater and the starting torque less, the efficiency also falling below that of the motor with the variable resistance.

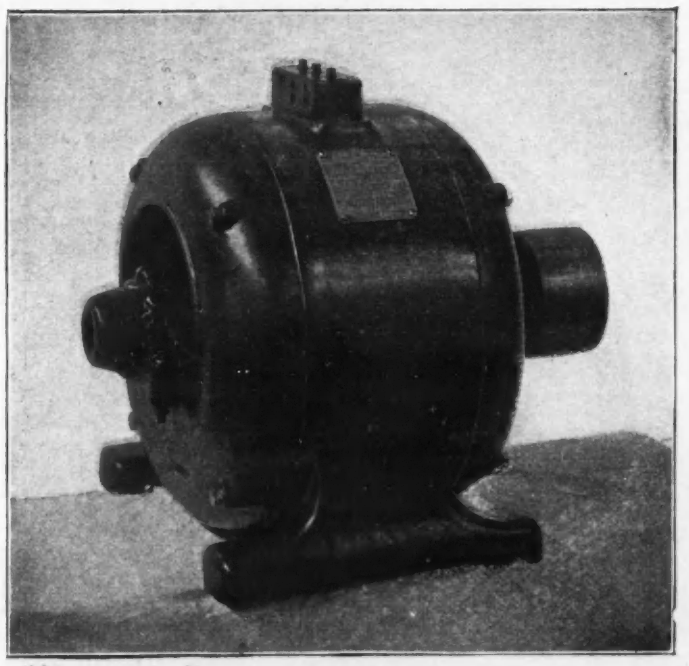
The field is wound with the conductors in slots, the winding being supported by end shields, which protect them from outside mechanical injury. The connection board on the motor has no bare terminal connections and no part of the active conductors are exposed.

The full load rating is not the heating limit, but is determined by the safe margin allowed for the overload carrying capacity. The rise in temperature above the surrounding atmosphere when run continuously for 10 hours at the rated full load is not over 45 degrees centigrade.

The speed, practically constant, does not vary with changes of voltage and cannot exceed the rated speed. If speed variation is required on the three-phase motors it can be obtained by the addition of collector rings and brushes and a rheostat in the armature circuit. No speed variation is readily obtainable in the single-phase induction motor.

The starting torque and starting current of the three-phase high-frequency motors, with resistance in armature, are from 25 to 30 per cent. in excess of the torque and current at rated load. For special cases the motor can be built for a much greater starting torque.

The single-phase motor requires a starting box, starting it with half-load torque and about one and a half full-load current in the case of the motor with variable armature resistance. The box consists of a non-inductive resistance and a choking coil, the object being to establish a displaced phase of E. M. F. and produce a starting torque. When the motor



INDUCTION MOTOR.

is up to speed the box is cut out, and the motor then runs as a simple single-phase motor. This motor can also be started with full-load torque and a little over twice full-load current, but this necessitates a larger box. The single-phase motor, with independently short-circuited coils or fixed resistance in the armature, requires about twice this amount of current when starting and gives somewhat less torque.

These induction motors are totally without moving contacts, and are standard for 104 volts. The smaller sizes can be run upside down or sideways, or fastened against the wall, thus greatly economizing floor space.

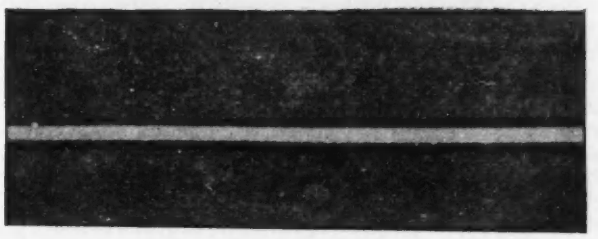
The high-frequency three-phase motors have been designed to meet a demand for power service principally from high-frequency monocyclic generators, and may be wound two-phase for use on two-phase circuits of similar frequency.

The single-phase motor meets the demand created for a motor to be operated on the existing high-frequency alternating-current systems.

A New Lamp Filament.

We illustrate herewith an incandescent lamp filament made by a new process, recently put in operation, for which is claimed much better results than heretofore known.

The photograph is a microscopic enlargement of 30 diameters, by which the most minute imperfections of the filament can be readily seen. The homogeneity and beautiful silvery, mirror-like surface of the carbon suggests at once its great utility in making lamps of uniform high efficiency. As most troubles with lamps come from poor filaments, the regularity of lamps manufactured with such a filament can be readily



LAMP FILAMENT, ENLARGED.

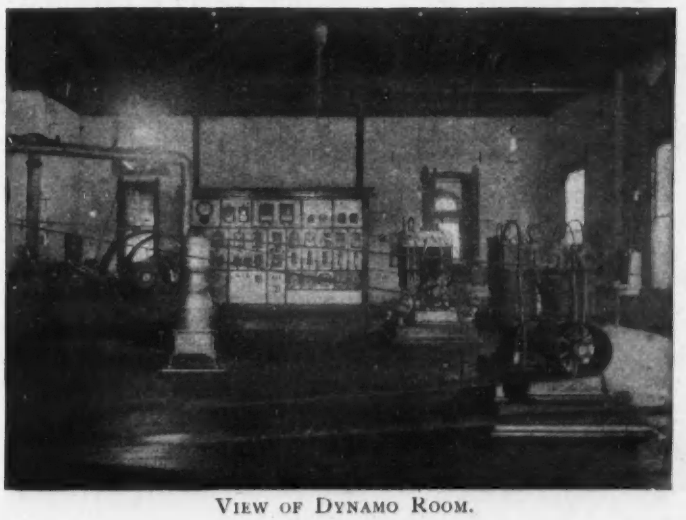
appreciated. The original body (here shown in a finished form), after carbonization, is purposely rough, to afford a better welding contact for the deposited carbon. The smooth and glassy surface is only given by reason of the flashing or method of treatment.

It has been found that the least amount of radiation takes place when the carbon filament combines the following two essential features: a smooth, closely-grained surface and as nearly white in color as possible. Just why the latter is true is not positively known. All the fusible metals which are white radiate less heat rays than others of equivalent areas; at least, a given expenditure of energy with such filaments produces more light.

When compared with some of the filaments illustrated last week, the Bryan-Marsh Company, New York, the makers of the Imperial lamp, in which this filament is used, is certainly to be congratulated upon having achieved a distinct advance in lamp manufacture.

Model Electrical Equipment in an Hospital.

A recent inspection of the electrical equipment of the Central Indiana Hospital for the Insane, at Indianapolis, Ind., showed a striking example of an application of electricity where great economy of labor has been achieved and the conditions surrounding the operator vastly improved. The complete electrical plant has been in full operation for about a year. The equipment consists of three Phœnix boilers, with a total capacity of 450 horse-power; two 125-hp Phœnix centre crank, high-speed engines,

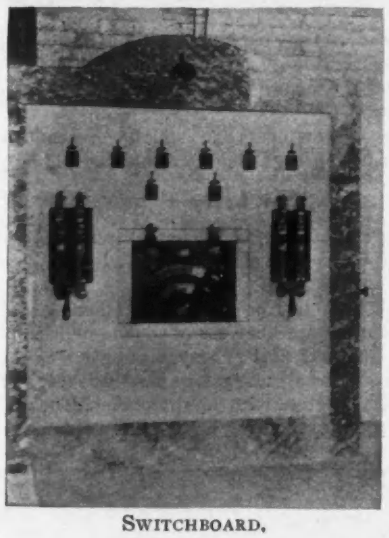


VIEW OF DYNAMO ROOM.

each engine being belted to two 45-kw Edison bi-polar, compound-wound, 110-volt generators; one 65-hp Phœnix engine, belted to one 25-kw generator of the same type, and one 20-arc light Edison generator. The three-wire system is used for all isncandescent and power distribution, and all

mains distributing to the different buildings, for both arc and incandescent work, are underground.

In addition to the usual switchboard equipment, all mains have separate ampere-meters and voltmeter connections. The buildings are wired



Switchboard.

for 3020 16-cp incandescent lamps for lighting. The 20 arc lights are used to light the campus, groves and drives, the grounds being very extensive, comprising several hundred acres. One three-hp motor is belted to exhaust a fan in the generator room, and one 25-hp motor is belted to countershaft, driving the line shaft running 12 steam washing machines, two sterilizing machines, four centrifugal extractors, two starching machines and one tumbling machine, all made by the American Laundry Machine Company, also driving one Troy mangle, skirt ironers and one or two smaller machines.

In the laundry there is placed a handsome switchboard equipped with knife switches for controlling the supply of current to 32 laundry irons; also the automatic motor starter and the motor and main line switches. The equipment for electric sad-irons is unique. In one of the illustrations is shown one of the tables arranged for 12 operators. All tables are of the same dimensions. The wires are brought to the tables through conduits under the concrete floor and distributed beneath the tables to each upright, through which they pass to porcelain sockets at the ends of the bent pipes. In each socket is inserted a fusible plug attached to a flexible cord leading to the iron, depending in such position that it is always at the right and back of the operator. Small knife switches are conveniently placed near the base of the pedestal for the use of each operator.

Only one-half of the number of employees are now used that were required in the old laundry, using irons heated with natural gas. This electric ironing installation was made by the American Electric Heating Corporation of Boston, through its Chicago representative, Mr. F. P. Luther. The saving in cost of labor alone (natural gas being used for fuel in generating electricity) is more than sufficient to cover the total cost of the new method.

Ironing Room.

Much credit is due to E. E. Frost, chief engineer, for the well-arranged and well-ordered machinery plant; and for the electrical work, including the design of the table, the arrangement of the stands and many unique features, Joseph H. Stewart, the electrician, is responsible.

The Thomson Recording Wattmeter.

Our readers will recall recent correspondence which passed between Mr. James Milne and Mr. C. D. Haskins regarding the merits of the Thomson recording wattmeter. We learn that within the past month a series of important tests have been made to determine the accuracy of the meter in question under certain conditions. The tests were carried out to verify sundry criticisms to the effect that on rapidly fluctuating loads the meter was derelict in its accuracy—especial reference being made to elevator work. The object of the tests was the determination of the mean error under maximum conditions of fluctuation, and the result was gratifying from the standpoint of the meter. It was found that the maximum of error, introduced by this character of load—*i. e.*, under the worst possible or maximum condition of fluctuation—did not exceed $\frac{6}{10}$ of 1 per cent., a percentage materially reduced under conditions less than the maximum.

Accumulator Plant at the New York Custom House.

A battery of 130 type E 15 chloride accumulators has recently been installed in the New York Custom House for the purpose of night lighting after the steam plant has been shut down. It is contained in a room just off the engine room, and represents the highest degree of perfection in accumulator practice.

In The Electrical World of July 18, 1896, was given a description of the isolated generating plant in the New York Custom House. It contained a brief reference to the then proposed accumulator plant, giving a few general details of the same. The plant having now been completely installed, we are able to give further details of interest to our readers.

The cells are arranged in the usual manner in tiers on racks (Fig. 4), each cell resting in a wooden tray containing a layer of sand; the trays are mounted upon glass insulators. The sand furnishes an even foundation for the jars and also absorbs any moisture that may accumulate on the outside surface of the jars. The glass insulators are of a special form, and each is made in two parts, one—the lower—being cup-shape, into

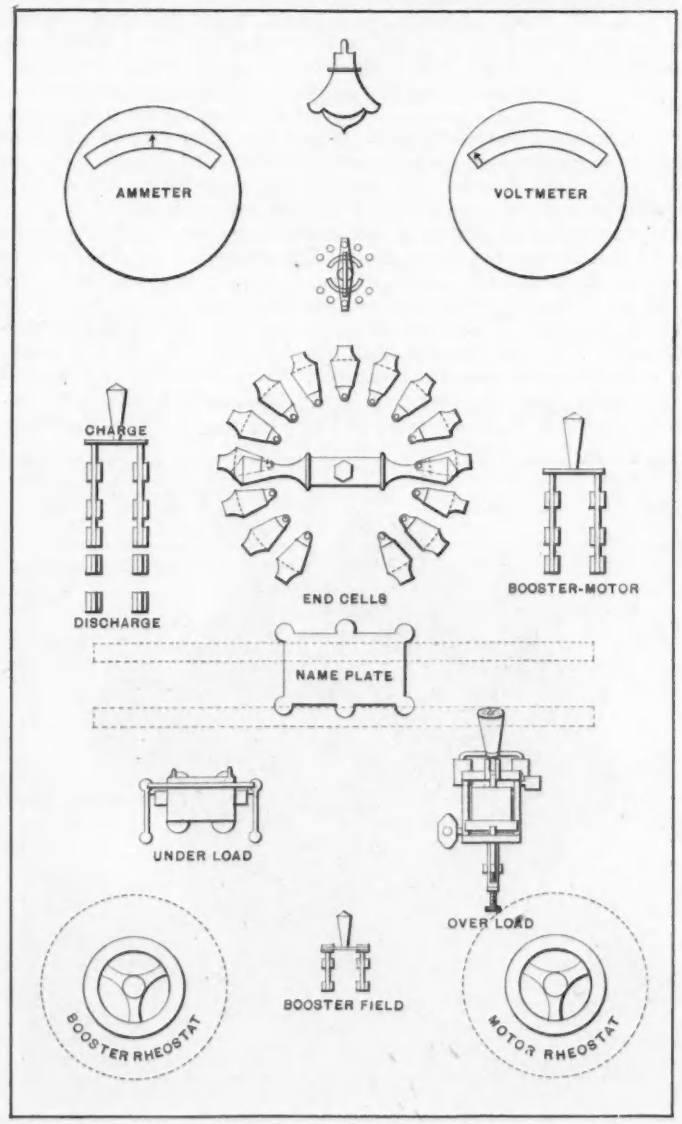


Fig. 1.—Elevation of Switchboard.

which a little oil is placed, and covered with the other, upon which the corner of the tray rests. This provides an efficient oil insulator and prevents any leakage of current.

The size of the cells is 14½ inches high by 9 inches wide, and that of

each plate 7¾ by 7¾ inches. The battery has a capacity of 280 ampere-hours at 220 volts, the capacity of the plant being sufficient for 12 hours continuous use. The plates rest upon porcelain supports to keep them from contact with the glass containing-jar. These supports in cross-section are in the form of an inverted V and are as long as the interior dimension of the cell, two of them being used in each jar.

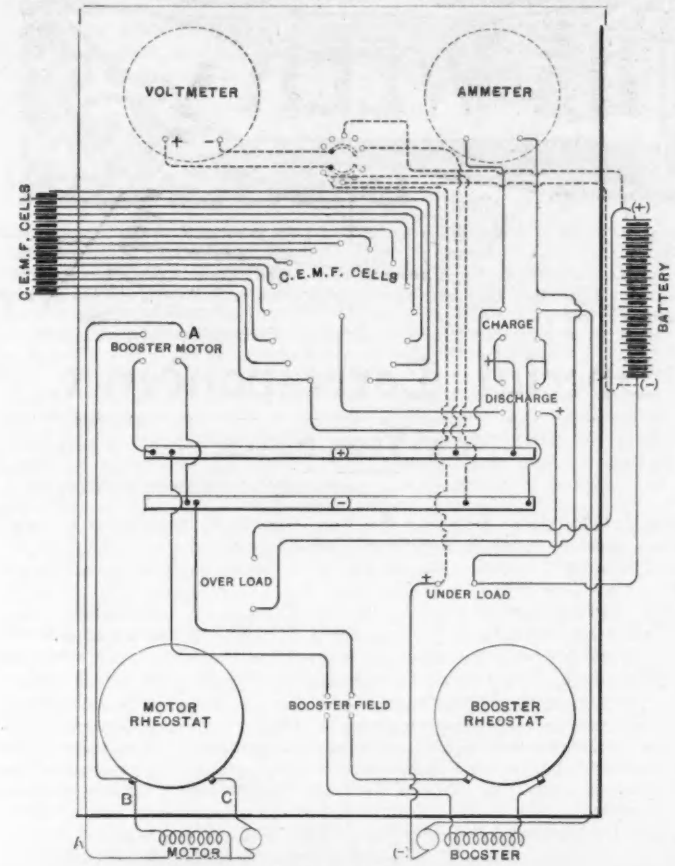


FIG. 2.—SWITCHBOARD CONNECTIONS.

The plates are kept at equal distances apart by means of hard rubber devices in the form of a hair pin, but closed at both ends, forming a parallelogram with rounded ends, the interior openings being just sufficient to easily slip over a plate. Along the sides of the pins there are half a dozen spherical enlargements to provide points of least contact with the plates, and at the same time permit of free circulation of the electrolyte.

In connection with these cells, and additional thereto, are 18 others which perform an important service. They are called counter E. M. F. cells for the reason that they are connected in series and in opposition with the main battery for the purpose of regulating the voltage in the latter. When the batteries are ready for use the voltage of each cell is given as 2.1 at the beginning of the discharge.

As the voltage of the main battery drops the counter E. M. F. cells are cut out successively by means of a switch on the switchboard, and in sufficient number to restore the voltage to the normal, *i. e.*, 220.

The auxiliary or counter E. M. F. cells are charged once for voltage, but not for capacity.

This method of voltage regulation has been found to work very well in small plants, and is more economical than rheostatic control. In large battery plants, however, the same results are attained by adding extra cells to the main battery to compensate for drop of voltage.

A "booster" (Fig. 3) raises the voltage for the purpose of charging the accumulators. The dynamo end generates 35 amperes at 120 volts, the motor operating at 220 volts, which is the voltage of the regular plant.

The switchboard (Fig. 3) is of Tennessee marble, and stands in the engine room near the booster. It was manufactured and installed by the Electric Storage Battery Company, Philadelphia, Pa., which, in fact installed the entire accumulator plant. The board contains a Weston voltmeter and a Weston ammeter, a counter-cell switch with 15 points to control the counter electromotive cells, a double-pole double-throw switch for use in charging and discharging the main battery, a motor-starting switch, a motor starting box, a booster field switch, a Carpenter enamel rheostat for the booster, an automatic underload cut-out and an automatic overload cut-out, all compactly and symmetrically arranged. The underload and overload cut-outs were made by the Cutter Electrical & Manufacturing Company, Philadelphia. The former automatically breaks the connection between the dynamo and battery should the charging current for any reason fall to a value lower than the total E. M. F. of the battery, and thus averts the danger of reversal of the dynamo. The overload cuts off the battery should the discharge rate exceed a predetermined limit.

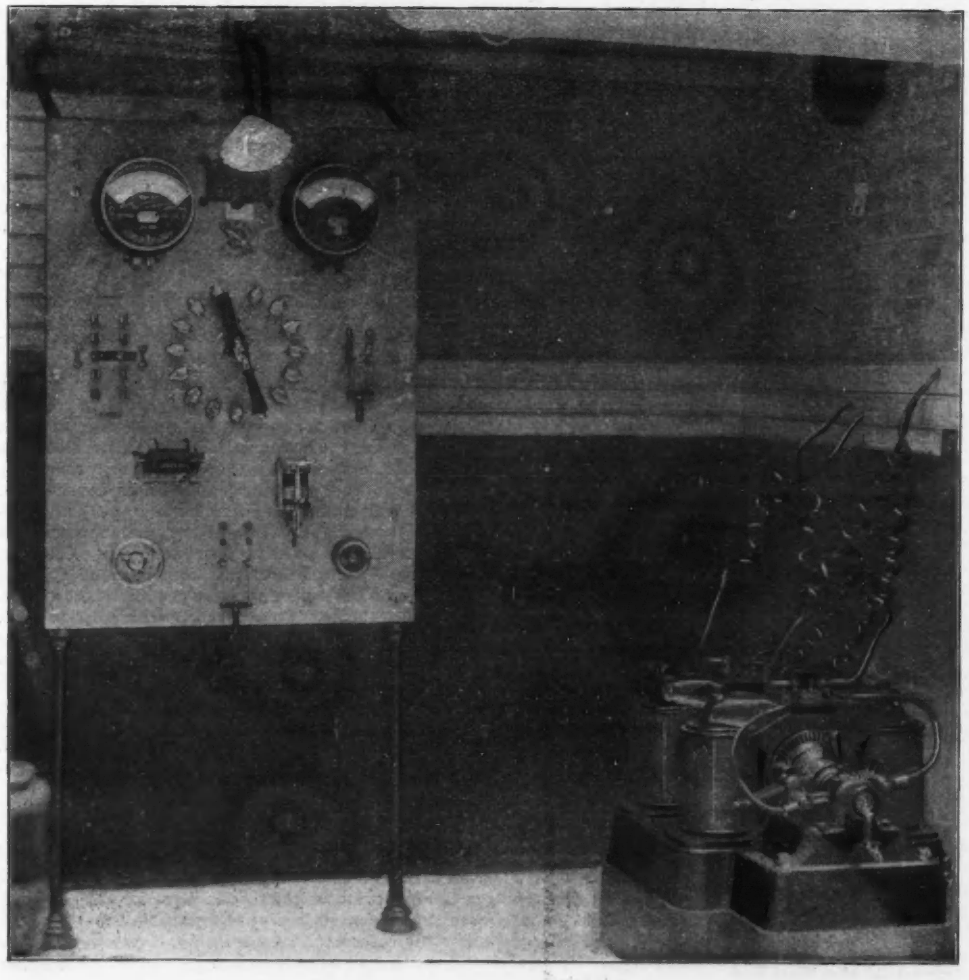


FIG. 3.—VIEW OF BOOSTER AND SWITCHBOARD.

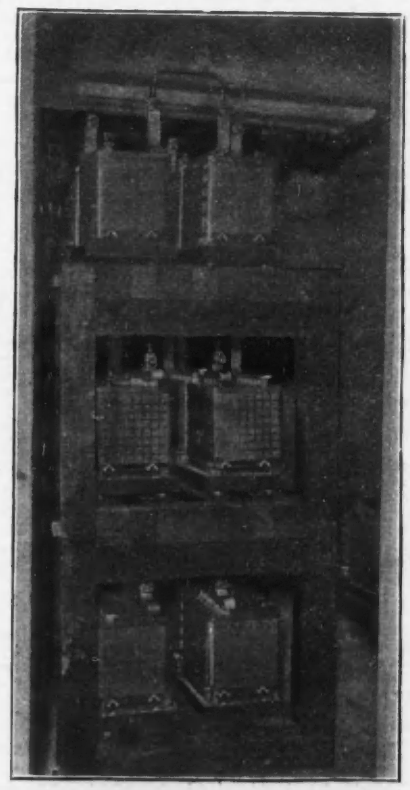


FIG. 4.—THE ACCUMULATOR PLANT.

Figs. 1 and 2 are diagrams of the front of the switchboard and the connections at the back.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Nov. 21, 1896.

ELECTRICAL STOCKS.—The general rise reported last week was not maintained during the week just past, although the losses were not as great as were the advances of the previous week. The only exception to the general decline was Edison Electric Illuminating, of New York, which advanced ½ point. General Electric lost about 1 point and Electric Storage Battery, both common and preferred, dropped a like amount. No change is reported in Westinghouse securities.

TELEGRAPH AND TELEPHONE stocks show a slight improvement as compared with prices a week ago, the single exception being Western Union, which dropped off 1⅞. Dealings in this stock were quite large, amounting to 20,046 shares. Bell Telephone advanced one point to 206 bid, the asked price being 210, while Commercial Cable heads the list of advances with a record of five points better than last week's quotation.

TRACTIONS.—The market for street railway securities was rather dull and featureless during the past week, although prices show some slight improvement, as compared with last week's quotations. The general list shows fractional advances, the only exception being West End common, which lost 3 points. This was the greatest change in the whole list. The street railway bond market seems to be stronger, what few changes are recorded being for the better.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	..	..
Edison Electric Ill., New York	100	100½	102
" " " Brooklyn	100	88	93
" " " Boston	100	..	..
" " " Philadelphia	100	..	..
Edison Ore Milling	100	7½	10
Electric Storage Co., Philadelphia	100	29½	29¾
Electric Storage, pref	100	31½	32
General Electric	100	32¾	33
General Electric, pref	100	70	..
Westinghouse Consolidated, com	50	25	..
" " pref	50	50	51½

BONDS.

Edison Electric Ill., New York	105	105	..
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	92½	..

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	206	210
American District Telegraph	100	*29	39
American Telegraph & Cable	100	90	91
Central & South American Telegraph	100	124	127
Commercial Cables	100	150	..
Erie Telephone	100	63	..
New England Telephone	100	99½	..
Postal Telegraph-Cable	100	88½	90½
Western Union Telegraph	100	86⅝	87

ELECTRIC TRACTION STOCKS.

Baltimore Traction	25	17¾	17⅞
Brooklyn Rapid Transit		21	22
Brooklyn Traction	100	..	14
" " pref	100	46	48
Buffalo St. Ry	100	77	79
Cleveland Electric Ry	100	..	..
Columbus St. Ry	100	44	46
Hestonville	100	51	52
" pref		..	62½
New Orleans Traction	100	9	11
" " pref	100	40	50
North Shore Traction	100	22	25
" " pref	100	77	80
Rochester St. Ry	..	17	20
Steinway Ry	..	45	50
Union Railway (Huckleberry)		98	103
Union Traction, rcts $10 pd	..	12¾	13
West End, Boston	100	65	66½
" " pref	100	89½	..
Worcester Traction	100	19	21
" " pref	100	92	97

BONDS.

Brooklyn Rapid Transit 5s. 1945	100	77	..
Buffalo St. Ry. 1st con. 5s	100	*107	..
Cleveland Elec. Ry. 1st mtge 5s	100	100	*103
*Columbus St. Ry. 1st 5s	100	95	100
Rochester St. Ry. 1st 5s	100	..	98
Union Railway (Huckleberry) 1st mtge 5s		*101	104
*Westchester Electric 1st mtge 5s	100	100	103

* With accrued interest

WEST END ANNUAL REPORT.—The annual report of the West End Street Railway Company, Boston, for the year ending Sept. 30, 1896, shows the following general results: Gross receipts, $8,341,058; operating expenses, $6,334,619; net, $2,007,339. According to President Little's report the gross earnings show a satisfactory increase over those of the preceding year. The rated horse-power of all the stations at the date of the report was 25,550. During the year 25.014 miles of new track were laid. At the present time the company has conduits 4.84 miles in length; length of ducts 66.27 miles; length of cable, 29.51 miles. The equipment account shows that the company has 336 horse cars, 1065 electric box cars, 1021 open electric cars, 11 mail cars, 548 horses and 2681 electric motors.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, Nov. 23, 1896.

MORE ELECTRIC LIGHTS.—The Gas Commission has agreed to erect 100 new electric lights on Sedgewick, Albany and Van Courtland Avenues, in the annexed district. The new lights will increase the expense $16,400 a year.

THE CATHODOSCOPE ELECTRICAL COMPANY, 50 Broadway, New York, has been attached for $3,325 in favor of Edwin Hammerschlag on an assigned claim for balance due on patents sold to the company by Arthur A. Hammerschlag. This company dealt in apparatus for Röntgen ray exhibitions.

MR. WILLIAM S. TURNER informs us that he will carry on a consulting and constructing engineering business in electric railways, lighting, power transmission and steam engineering, similar to that heretofore conducted by the Woodbridge & Turner Engineering Company, which concern recently discontinued business. Mr. Turner's office is in the Postal Telegraph Building, 253 Broadway.

THE HENRY ELECTRICAL SOCIETY.—Among the topics to be considered before this society in the near future are the following: On Dec. 4, Prof. F. B. Crocker will explain the principles of electro-chemistry, and by the aid of experiments and the lantern the treatment will be rendered especially interesting and particularly valuable. On Dec. 18, Dr. L. H. Laudy will describe the different methods of lantern projection, including searchlights.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The annual convention of the American Society of Mechanical Engineers will take place in the Society's parlors, No. 12 West Thirty-first Street, New York City, on Dec. 1, and will continue until Dec. 4. The convention will be opened at 9 o'clock p. m., on Dec. 1, and some excellent papers are laid down on the programme to be read during the meetings. Among the papers of general interest to electrical engineers may be mentioned the following: "Promise and Potency of High Pressure Steam," by R. H. Thurston; "Contraction and Deflection of Iron Castings," by Francis Schuman; "Friction Horse-Power in Factories," by C. H. Benjamin; "Rustless Coatings for Iron and Steel," by M. P. Wood; "The Efficiency of the Boiler Grate," by W. W. Christian; "The Efficiency of Boiler Heating Surface," by R. S. Hale, and "Steam Engine Governors," by Frank H. Ball. The entertainment part of the programme is quite elaborate, and the delegates will visit various places of interest throughout the city and vicinity.

MAGNETIC CLUB DINNER.—On the night of Nov. 18 the regular Autumn dinner of the Magnetic Club was held at "The Tuxedo," corner of Madison Avenue and Fifty-ninth Street. There were over 150 gentlemen present, including a large number who occupy prominent positions in the electrical trades and professions. An elegant dinner was served, after which there was a fine entertainment programme. The after-dinner exercises consisted of vocal and instrumental music of high class, all of which was greatly appreciated and well received by the gathering. A feature of the entertainment was the character singing by three ladies from the professional stage. The delegates to the Telegraphers' Mutual Benefit Association, the annual meeting of which was held on the afternoon of the same day, were present at the dinner, as were also several delegates from the newly organized Boston Electric Club. The meeting was undoubtedly the most successful and entertaining ever given by the Magnetic Club. Among the prominent persons present may be mentioned President A. B. Chandler, of the Postal Telegraph Company; Frank J. Sprague and Charles A. Benton, of the Sprague Electric Elevator Company; William Marshall, of condenser fame; J. E. Ham, general agent for W. R. Brixey; F. W. Jones, electrical engineer of the Postal Telegraph Company; H. L. Shippy, manager of John A. Roebling's Sons Company, and many others.

BUFFALO AND NIAGARA FALLS NOTES.

BUFFALO, N. Y., Nov. 20, 1896.

APPLICATIONS FOR MORE POWER.—Secretary William B. Rankine, of the Cataract Construction Company, states that since election his company has received from its present tenants on its lands in Niagara Falls applications for a total of 5000 additional horse-power. Accordingly, it was decided to place in position as soon as possible five new dynamos, instead of three, as was originally intended.

MORE NIAGARA POWER TO BE USED.—The contract was awarded by the Mathieson Alkali Company, of New York City, for the construction of its big plant in Niagara Falls, to Wentforth & Taylor and R. D. Young. The buildings will cover two acres, the main one being 200 by 300 feet. The first

section of buildings must be completed Jan. 15. This company manufactures caustic soda by the Castner process, and will use 2000 horse-power, employing 150 men. It has factories at present in Saltville, Va., and England.

CANADA POWER DEVELOPMENT.—The announcement that options were being taken on the Canadian side of the river, and that new men were interesting themselves in power development there has created quite a stir here. When the matter of the possibility of new men being willing to take hold was first brought to the attention of the public about three weeks ago by the hearing in Toronto, people here did not think so much of it, but now it appears that local men are looking up the matter, and one is getting options on the strength of a possible change.

ENGLISH PLANT CLOSED.—President A. E. Hunt, of the Pittsburg Reduction Company, informs me that the English plant of the Reduction Company has been shut down. This plant was started in 1890 at Patricroft, a place between Liverpool and London in the Black Country. It was on the line of the London & North Western Railway and in the vicinity of the great chemical district known as Widness and where coal is as cheap as anywhere in Great Britain. The plant was as well equipped as the development in electricity in those years would permit, but he found he could not compete in cost of manufacture of aluminum with the metal produced by water-power. He closed the plant and found it cheaper to export from this country than to manufacture by coal in Great Britain.

NIAGARA FALLS ELECTRIC RAILWAY PETITION GRANTED.—Considerable interest was felt here in the announcement from Albany that the State Board of Railroad Commissioners had handed down a decision giving the Niagara Falls Railroad Company a right to construct its proposed road. This matter has hung fire for a long time. The Railroad Commissioners gave a hearing upon the matter in the Chamber of Commerce rooms in this city early last Spring, and reserved its decision. As is well known the Niagara Falls & Suspension Bridge Street Railway Company opposed the proposed new railway, and the Hon. W. Caryl Ely, president of the Buffalo & Niagara Falls Electric Railway Company, appeared before the commissioners and made a strong argument against the favorable consideration of the application.

THE NEW PLANT of the Pittsburg Reduction Company, known as the "Lower Works," located on the high bank of the river below the Falls, was started up to-day when the electric current was turned onto the pots in the furnaces. The peculiar interest in the starting up of this new plant is that it inaugurates the first use in an extended or large way of aluminum rods as conductors of electricity. The Pittsburg Reduction Company, as previously noted in THE ELECTRICAL WORLD, resolved to use aluminum rods or cables instead of copper for conducting the current from the generators in the power-house down in the gorge, some 200 or more feet to the plant on top of the bank. These rods are each ⅜-inch thick in diameter and 350 feet long from the generators to the main line in the furnace or pot room. These main line conductors which traverse the pot room are from 12 to 16 inches wide and an inch thick, and are also of aluminum. It is now announced that the Pittsburg Reduction Company will establish a Canadian plant and have it in operation some time next year. This plant will be established on the Canadian side of the river and the site has already been secured above the bluff back of the electric power-house of the Niagara Falls Park & River Railway.

PHILADELPHIA NOTES.

Branch Office of THE ELECTRICAL WORLD,
927 Chestnut Street,
PHILADELPHIA, Pa., NOV. 21, 1896.

MR. JOHN E. KELLY, 411 Cherry Street, Philadelphia, Pa., is doing an excellent business in electric bell work. He has a branch establishment at 429 Spruce Street, Camden, N. J; also one at Lindenwald, N. J. He is a practical man in this particular line.

LIGHTING THE CITY HALL TOWER.—The tall tower of the City Hall is to be illuminated by two rows of arc electric lights which will set off the figure of William Penn and the tower itself to great advantage at night. The proposition will be made at the next meeting of the Public Building Commission, and it is stated that the plan will probably be adopted.

THE ELECTRICAL SUPPLY & TELEPHONE COMPANY, 1429 Chestnut Street, Philadelphia, is doing a large business in telephones, electric gas lighting, electric bells, incandescent lighting supplies, etc. It makes a specialty of telephones and has had large success in this line. Its telephone instruments are as cheap as is consistent with the first-class product, and are guaranteed to give excellent service. Every instrument, it is stated, is guaranteed free from patent complications.

NEW ENGLAND NOTES.

Branch Office of THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, MASS., NOV. 20, 1896.

THE COLBURN ELECTRIC MANUFACTURING COMPANY have recently furnished the O. C. White Company, Worcester, Mass., with a dynamo for its incandescent service. The dynamo is running very satisfactorily. Each light is mounted on an adjustable holder of the O. C. White Company's manufacture and the plant, taken as a whole, furnishes an instructive object lesson in modern shop lighting.

THE GENERAL ELECTRICAL ENGINEERING COMPANY is a new concern just started in business in Boston. Its headquarters are in the Tremont Building, and it will carry on a business of general electrical contracting. The company will prepare plans and specifications for complete steam and electric plants for railway, lighting and power purposes. Every feature of the electrical engineering profession will be given proper attention by the new company.

MR. J. D. LEATHERBEE, treasurer of the National Telephone Manufacturing Company, of Boston, writes to THE ELECTRICAL WORLD to say that as far back as May 18, 1895, suit was brought by the Western Electric Company against the National Telephone Manufacturing Company for alleged infringement of the Watson telephone switch patent, and when Mr. Richardson, counsel of the Western Electric (American Bell) Company, was informed that the Watson patent was void on account of expiration of foreign patents, the case was dropped and nothing has been heard from it since. Mr. Leatherbee thinks it strange that Messrs. Barton and Brown should at this late day write the lawyers of the Standard Telephone & Electric Company, of Madison, Wis., that they had just found out about these foreign patents.

THE HOPE ELECTRIC APPLIANCE COMPANY, Providence, R. I., has recently acquired new blood and new life generally. First it has installed itself into a spacious new home in the new Metcalf Building, 144 Pine Street, where it has abundant facilities for the manufacture of its well-known specialties and the general conduct of its business. Another important move is the addition to its manufacturing business of a construction department, under the management of Mr. John I. Drake, who is one of the conspicuous "old timers" in the electrical business. Mr. Drake, being possessed of inventive genius, has contributed to the electrical industry several valuable specialties, notably an admirable mast arm. As is well known, the Hope Electric Appliance Company manufactures mast arms, cut-out boxes, switches for alternating current and high and low tension, and current and pressure recording gauges. Mr. Robert Fessenden, its president, is an energetic and wide-awake business man, and has secured for these specialties liberal recognition and a strong foothold, which will without doubt be materially increased and strengthened through the valuable knowledge and assistance of Mr. Drake. Mr. William Ely is the secretary of the company, and is also well and favorably known to the electrical trade.

WESTERN NOTES.

Branch Office of THE ELECTRICAL WORLD,
936 Monadnock Building,
CHICAGO, ILL., NOV. 19, 1896.

FOREIGN EDITION.—*The Street Railway Review*, Chicago, will, commencing January, 1897, publish a foreign edition for circulation outside of the United States. The foreign edition will be issued quarterly for the present.

THE ELECTRIC APPLIANCE COMPANY, Chicago, reports a good lamp business during the months of October and November. The Packard lamp not only holds its own, but gains ground every year in a way that indicates clearly that it is made of the right kind of stuff and has lasting merit.

MR. A. M. SEARLES, general manager of the Diamond Electric Company, of Peoria, Ill., reports that his company has increased the number of employees considerably, and is running full 10 hours every day. Having recently made some marked improvements in the Scheeffer wattmeter and brought out the new Scheeffer transformer, the company is receiving numerous inquiries from all parts of the country for these goods. The new direct-current meter that has been developing during the past year will probably be ready to put on the market early in January.

PARIS NOTES.

PARIS, Nov. 10, 1896.

ELECTRIC LIGHTING OF THE AVENUE DE L'OPERA.—As is well known, the lighting of the Avenue de l'Opera was carried out electrically in 1878 by means of Jablochkoff candles. At the present time the municipal service is supplying light with the aid of 48 arc lamps. These lamps have been placed in candelabra 5½ metres high, of the model adopted by the city. Forty-four candelabra are placed in rows, 22 on the right and left respectively, and four are placed in the shelter near the crossings. Alternating currents will be used. The arcs operate at 10 amperes, and will be supplied four in series on a 220-volt circuit supplied by two transformers coupled in series. These transformers will be placed in a small pavilion, the lower part of which will contain the switchboard and accessory apparatus. It is expected that the installation will shortly be finished.

ELECTRIC TRACTION IN PARIS.—Electric traction has not yet taken a very large development in Paris. Little can be expected of the accumulator lines of Saint-Denis and that of Claret-Vuillemier. Although the omnibus company has decided to adopt either the overhead or underground trolley system, one can nevertheless find few accumulator lines running from the centre of Paris to the suburbs. Among others we may cite the new lines of the Madeleine-Courbevoie, Madeleine-Bineau-Courbevoie, Madeleine-Levallois and Neuilly-Avenue-du-Roule. These lines employ rapid-charge accumulators of the Tudor system, the weight of the plates for each element being 15 kilograms. The batteries are re-charged on the car at the terminus with the aid of a 500-volt circuit after a system developed from that established at Puteaux, by the Société industrielle de moteurs Electrique et à vapeur. The charge at 120 amperes is effected in 15 minutes, being about eight amperes per kilogram of plate. The entire battery is composed of 200 cells of five plates each, of which there are two positive and three negatives, having a capacity of at least 32½ ampere-hours. This charge is sufficient to run a car a round-trip of about seven kilometres under the condition of not exceeding a velocity of 12 kilometres in Paris and of 16 kilometres in the suburbs. These lines are of an experimental nature.

SOCIÉTÉ INTERNATIONALE DES ELECTRICIENS.—The Société Internationale des Electriciens has renewed its meetings. M. Hillairet, general secretary, who was a delegate to the Congress of Geneva, tendered a report of the congress proceeding, with the conclusions which had been arrived at, and requested that thanks be voted to M. Palaz, to M. Turettini and the Swiss Association of Electricans for their gracious hospitality. M. Perrin explained the discharge of electrified bodies due to Röntgen rays. His explanations were all of a theoretical nature. For an electrified body to discharge it is necessary that the rays meet the lines of force emanating from the body. A tube of force cut by the Röntgen rays and located in the gas comprises a conductor. These rays can then charge an isolated body which is placed in an electrostatic field. The quantity of electricity which flows along the length of the tubes of force will be that which the rays had dissociated. M. Perrin made some experiments of charging and discharging which justified these explanations. M. Paul Janet rendered a communication on the temperature o

filaments of incandescent lamps. Three figures only have heretofore been determined. In 1886 M. Garbe found 2250 degrees C.; in 1891 M. Weber found 1300 degrees C., and in 1892 M. Lechatelier found 1800 degrees C. M. Garbe has applied the optical method of M. Crova. M. Lechatelier has compared the red radiations of a source with a standard by means of the Cornu photometer, which he has graduated by a thermo-electric couple, knowing the temperature corresponding to the luminous intensities. M. Weber, of Zurich, has established a formula based upon the radiation which gives the quantity of total heat radiated per second as a function of the temperature. This formula reduces itself to the following simple expression: $Q = C S T \varepsilon^{a T}$, where Q is the quantity of heat diseng aged, C, a constant characteristic of the body employed and which for carbon is equal to 0.000043 S is the incandescent surface, T is the absolute temperature of the source, a is a constant which is the same for all bodies and equal to 0.0043. Previous experiments at known temperature permit of the determination of a The new method of M. Janet consists in determining the wasted power in the lamp as a function of its resistance. The resistance being itself a function of the temperature, we then know the wasted power and as a consequence the heat radiated with a given temperature. We can trace accordingly the curve of cooling of a lamp as a function of the time by rapidly breaking the circuit and measuring successively all values of the resistance, thus knowing the quantity of total heat given off by the filament during cooling. In employing the formula of M. Violle, which gives the quantity of heat furnished by a gramme of carbon for the maintenance of a given temperature, we can easily determine this temperature. M. Janet explained that the measurement of the variation of resistance was carried out by placing the lamp in one arm of a Wheatstone bridge. Some precautions should be taken in order to measure these variations during cooling. Toward the end of the meeting M. Pellat rapidly indicated the method of graduation of a Deprez-d'Arsonval galvanometer.

General News.

Telegraph and Telephone.

INDIANAPOLIS, IND.—The Western Union Telegraph Company has signed a contract with the city for placing its wires under ground.

COLUMBIA, PA.—The Borough Council granted the Columbia Telephone Company the right to erect poles and wires and operate its line in the borough.

CHICAGO, ILL.—Corporation Council Beale has submitted an opinion to the Judiciary Committee of the City Council, to the effect that the city has no power to regulate the charges of the Chicago Telephone Company, and to prevent the use of the slot machine telephones.

PITTSBURG, KAN.—For the past month a telephone rate war has waged here, which, a few days ago, came to an end by one of the contestants giving up the fight. The Missouri & Kansas Telephone Company was the victor, and the citizens of Pittsburg were the vanquished parties.

INDIANAPOLIS, IND.—The Supreme Court of Indiana recently decided that a telephone company cannot arbitrarily refuse to make a connection because a subscriber refuses to make certain promises. Dr. Hudson had ordered his telephone taken out, owing to some trouble he had had with the telephone company, and, having had occasion to call for his horse, he used the telephone in a drug store. The exchange operator refused to make the connection between the drug store and the livery stable until the druggist would promise not to allow Dr. Hudson to use the 'phone. This was refused, as was also the connection, and the suit was the result. The company claimed that under the contract it had the right to refuse others than the subscribers to use the instrument.

Electric Light and Power.

MILES CITY, MONT.—The electric light plant is to be enlarged. A dynamo and other electrical equipments are to be purchased.

BARTON, FLA.—The question of establishing an electric light plant is being agitated and there is a strong sentiment in favor of the project.

HARTFORD, WIS.—Portz Bros. and J. B. Hahn, of this city, are considering the advisability of putting in an electric light plant in Hartford.

BALLARD, WASH.—Falcon Joslyn, of Seattle, is seeking a franchise to put in an electric light plant. The Council proposes to put in a municipal plant.

MAUSTON, WIS.—If the city gives permission for the erection of poles the Mauston Milling Company will put in a dynamo and furnish all who desire with electric lights

HAWLEY, PA.—Ex-Mayor W. L. Connell, C. D. Jones, S. W. Edgar, all of Scranton, have formed themselves into a company to supply Hawley with electric light and will apply for a charter on Dec. 1.

MINNEAPOLIS, MINN.—Plans and specifications have been prepared, and bids will be received for the equipment of the power plant below St. Anthony Falls. Wm. De La Barre is engineer and manager of the St. Anthony Water Power Company.

WASHINGTONVILLE, N. Y.—There is some talk in this place of establishing an electric light plant, and the matter is to be investigated by some of the leading citizens. It is believed that sufficient power for the purpose could be secured from the present water system.

TAUNTON, MASS.—The City Government has decided to refer to the voters the question of the purchase of the property of the Taunton Electric Lighting Company and to decide whether the city shall own its own lighting plant or continue to purchase current from a private corporation.

KEEWATIN, ONT.—The Keewatin Power Company has developed a water-power at the outlet of the Lake-of-the-Woods, which gives 30,000 available horse-power. Keewatin is 120 miles east of Winnipeg, Manitoba. The company proposes to deliver in Winnipeg 5500 horse-power to be used for lighting and power purposes. Tenders have been received from three leading companies, and a pressure of 25,000 volts has been guaranteed by each company. The Keewatin Company is already getting out the poles, and the plant will undoubtedly be pushed forward next Summer. There will probably be seven lines, and 1000-hp units will be utilized. Mr. Charles F. Medbury has been doing the consulting work for this company and drew up the general specifications of this installation.

The Electric Railway.

MASON CITY, IA.—A new power-house will be erected by the Mason City and Clear Lake Traction Company.

WESTFIELD, MASS.—The Woronoco Street Railway Company has ordered surveys for a trolley line to connect with the line of the Springfield Company.

BOSTON, MASS.—The Newton & Boston Street Railway Company has decided to extend its road to Great Plain Avenue, Needham, at once, providing a franchise can be secured.

NEEDHAM, MASS.—The Newton & Boston Street Railway Company has applied for a franchise in this place. The company proposes to extend its tracks from Newton Upper Falls. A public hearing on the application will be held on Dec. 7 next.

NEW YORK.—The Third Avenue Railway Company has been granted permission to extend its line from 162d Street, along Broadway and the King's Bridge Road to Spuyten Duyvil Creek, and to use the trolley system in the extension. By the terms of the permit the Public Works Department will have absolute control of the road until it is finished.

TIFFIN, O.—The Fostoria & Tiffin Electric Railway, which has been in an incomplete condition for the past four years, it is reported is about to be sold to eastern capitalists, who will at once complete the construction of the line. The distance between the two points is 14 miles, and two miles of track had been laid when the leading projectors in the enterprise assigned in 1892.

EAU CLAIRE, WIS.—The rights, franchise and property of the Eau Claire Street Railway, Light & Power Company, which have been in the hands of a receiver for the past year and a half, were sold at auction on Nov. 17 and bid in by Mr. E. N. Noyes, of Portland, Me., who represented the bondholders. The price paid was $20,000. The bonded indebtedness of the company was $43,800.

MR. A. LANGSTAFF JOHNSTON, the well-known supervising electrical engineer, who constructed among other electric railways the Hestonville system of Philadelphia, has just finished his work on the road for the Richmond Traction Company, Richmond, Va. On Nov. 9 the officers of the traction company entertained Mr. Johnston at an elaborate dinner, at the Westmoreland Club, and in the addresses paid many deserved compliments to his fidelity to duty and skill as an engineer. Mr. Johnston is leaving Richmond to superintend other work in Philadelphia. The line of the Richmond Traction Company was opened for business on June 19, 1896. Its total length at present is 12 miles, but 5 miles additional is under way. The gross earnings from June 19 (date of opening) to Sept. 30, 1896, were $38,537, the net surplus over all charges being $13,564.

Obituary Note.

DEATH OF FRANK P. ARBUCKLE.—Early on the morning of Nov. 19, Frank P. Arbuckle, a wealthy citizen of Denver, Col., was found dead at a lonely spot on Eighth Avenue, between 152d and 153d Streets, New York. Mr. Arbuckle was at one time connected with the telegraph service in the West and was located at Russell, Kan., on the Kansas Pacific Railway. He was one of the organizers of the Denver & Highlands Electric Company and was connected with many other large Colorado investment enterprises. Mr. Arbuckle it is thought, died of heart disease, and from the fact that a large amount of money and his watch and other jewelry which it is known he had upon his person when last seen alive were missing when his body was found, it is supposed that he was robbed of his valuables.

Trade and Industrial Notes.

CHARLES A. SCHIEREN & CO., New York, inform us that there is a very perceptible increase in the demand for their beltings, and there is every reason to believe that the near future will bring with it better business conditions.

FOREIGN TRADE.—The American Engine Company, Bound Brook, N. J., is about to ship one of its new American-Ball engines to the Chinese Government, to be used in driving machinery for the coinage of silver.

McROY CONDUITS.—John T. McRoy, 915 Chamber of Commerce, Chicago, has just issued a neatly gotten up catalogue on his well-known vitrified terra cotta conduit. The many good points embodied in this useful device are well presented.

WAGNER TRANSFORMERS.—The Wagner Electric Manufacturing Company, St. Louis, Mo., has issued its November catalogue and price list of the Wagner transformer. It gives a good deal of general and special information on the subject of transformers.

CROSBY & CORRAO have recently formed a copartnership as consulting and contracting electrical and mechanical engineers at 309 Summer Street, Lynn, Mass. They invite correspondence and will be pleased to furnish estimates and undertake engineering work of all descriptions.

GALE'S COMMUTATOR COMPOUND.—If you have not as yet tried Gale's Commutator Compound, and are troubled with sparking and cutting of commutators, send to K. McLennan & Co., Marquette Building, Chicago, for free sample stick. Gale's Commutator Compound, it is claimed, will absolutely prevent sparking and cutting, and will not gum the brushes.

MR. A. A. CHURCHWARD, of the Excelsior Electric Company, New York, is in the West on a business trip. Mr. Churchward is doing some good work in fostering interest in the Churchward Equalizer, which is controlled by the Excelsior Company. This system can always compensate for a drop in the

line at any point, independent of all others, and is practically equal to the booster equalizer.

LONG-BURNING ARC LAMPS.—The success which the General Electric Company's long-burning arc lamps is meeting from all sides is shown by the steady increase in the orders. In a recent letter from the superintendent of an important station in Maine is the following: "We have used the lamps for eight months with exceedingly gratifying results. Our customers are as well pleased as we, as increasing orders for them testify. We can commend this lamp most highly to electric companies wishing a lever against gas, and in places where the ordinary arc or incandescents cannot be installed."

THE SCOTT ELECTRIC LAMP COMPANY, New York, despite the very discouraging conditions of the two years since its formation, has netted 4½ per cent. on its capital during that time, which is a very creditable record. With rare good judgment, the company has not paid its earnings out as dividends, but has used them to extinguish the debt which it assumed. But little debt now remains, and this is mostly due to the company's own stockholders, and can be paid at its convenience. It has had more business offered than it could do. To keep up with the demand for its goods it has just opened a shop of its own, equipped with both steam and electric power, and is obliged to run double time. As the company's business with the new shop is increasing so fast that it will have to run double time for some months to fill orders, the dividends are reasonably sure to carry the value of the stock, not only to 300, but far beyond it; especially as the company has not been over-capitalized, but has a very moderate amount of stock compared with the value of its business. None of the stock is for sale; the holders naturally prefer to keep it. The great value of electric searchlights has been fully shown of late in New York Harbor, where they have been used by the United States Government with marked effect for giving warning of storms and for penetrating fogs. The managers of the company, it is claimed, were the men who solved the problem of a light that will penetrate fog and thus greatly benefited the public. Besides search lights the company make focusing lamps for photographers, theatres, etc., and oil searchlights for places where electricity cannot be had. It also does a variety of other metal-working.

Business Notices.

THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company, 67-71 Park Place, New York.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, 105 South Warren Street, Syracuse, N. Y.

THE THEORY OF SUCCESS.—The New York Central management evidently proceeds on the theory that the more care there is taken of a traveler the more he will travel—witness its "Limited" trains, block signals, free attendants and the comfort and luxury surrounding one from beginning to end of a journey on "America's Greatest Railroad."

THE LUXURY OF TRAVEL.—The man who has never been West over the picturesque New York Central has a sensation in store for him that he cannot afford to forego. Nature has done almost as much for him in what he sees as mechanical skill has done in placing him in a magnificent hotel on wheels, and whirling him toward his destination on the very wings of the wind.—*Hardware.*

HOME SEEKERS' EXCURSION.—On Nov. 17 and Dec. 1 and 15, 1896, the Chicago, Milwaukee & St. Paul Railway will sell round trip excursion tickets from Chicago to a great many points in the Western and Southwestern States, both on its own line and elsewhere, at greatly reduced rates. Details as to rates, routes, etc., may be obtained on application to any coupon ticket agent. or by addressing E. F. Richardson, general agent passenger department, New York City.

TRAVEL UP TO DATE.—The New York Central offers unequal advantages for through travel between the East and West It is the only Trunk Line entering the City of New York; its Grand Central Station is in the very centre of the metropolis, in the midst of the hotel, residence and theatre district; it is the only line protected its entire length by block signals; it has the fastest trains in the world: the finest equipment; scenery including the Hudson River, Mohawk Valley and Niagara Falls.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED NOV. 17, 1896.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

571,351. ELECTROMAGNETIC SIGNAL RECEIVING INSTRUMENT; S. D. Field, Stockbridge, Mass. App. filed Aug. 11, 1896. The combination in an electromagnetic appliance, of a continuous iron core forming a complete magnetic circuit, with two independent inducing coils wound over different portions thereof, and connected in parallel with each other in the same circuit, and two coils having similar magnetizing power, and being adapted thereby to develop in the said core opposite and equal magnetizations when the maximum current is fully established through them, but to act thereon successively and oppositely and to develop in polar projections or surfaces of the said core a definite polarity when the current is rising, or being established, and an opposite polarity when the current is falling, or being disestablished.

571,362. MAGNETIC SEPARATOR; J. B. Hamilton, Springfield, Mass. App. filed Dec. 5, 1893. In a magnetic separator, the combination with a revolving electromagnet cylinder and a revolving wiper. of a receiver located adjacent thereto and provided with a projecting bottom and backwardly turned lip or flange.

571,363. ELECTRIC GOVERNOR FOR WATER-WHEELS; W. W. Handy, Baltimore, Md. App. filed June 19, 1896. In an electric governor, the combination of a dynamo, a prime motor and mechanism for regulating the force applied to the prime motor, a solenoid, a reciprocating core in said solenoid, a double lever from which said core is suspended, having a number of projections on each end, and contacts with which the projections of the lever may engage, said contacts being connected with a source of current and said electrically-operated regulating mechanism.

571,399. TELEPHONE TRANSMITTER; D. N. Rowan, Irvington, N. Y. App. filed Dec. 10, 1895. In a telephone transmitter, the combination of flexible, non-conducting shelves, electrodes, and granular conducting material suspended on the shelves between the electrodes.

571,420 COMMUTATOR-BRUSH; A. K. Warren, New Brighton, N. Y. App. filed May 16, 1896. The combination of a commutator brush of material adapted to rub on a commutator, an extension piece of similar cross-section to the brush, and means for fastening the brush and extension together.

571,435. ELECTRIC RAILWAY SYSTEM; G. J. Forrey, Carlisle, Pa. App. filed Feb. 29, 1896. In an electric railway system, the combination with a surface track of a third rail arranged centrally between the main track rails, said third rail being sectional and comprising separate registering members, one of which members is formed with a rail tread and base flange, and both of which members have formed between their meeting faces a longitudinal wire-pocket, an insulated main conductor or feed wire encased in said longitudinal wire-pocket, and suitable contact devices having metallic connections with the main conductor or feed-wire.

571,440. CABLE CARRIER; E. L. Heidenreich and G. Monrath, Chicago, Ill. App. filed Aug. 15, 1896. The combination with the cable way and with a traveling car suspended therefrom, of an electric motor mounted on said car, a winch mechanism driven by said motor, a guide-block separately sustained upon a cable way at a defined distance from the car, a car block, and dual tackles extending between each block and the winch mechanism therefor.

571,441. ELECTRIC SIGNAL BOX; W. W. Hibbard, Rochester, N. Y. App. filed June 16, 1894. In a signal box, the combination with two boxes set one within the other and separated by a clear space, of four spiral springs at the corners connecting the boxes and sustaining the interior one and insulators around which the springs rest, said insulators constructed with cores that enter the hollow of the springs, and end flanges that prevent contact of the spring with the boxes.

571,445. ANNUNCIATOR; F. A. Jennings, Ithaca, N. Y. App. filed May 11, 1895. In an annunciator, a dial provided with a series of notices, a pointer-shaft, a pointer thereon, a ratchet on said shaft, a battery, an electromagnet having a swinging armature, and two pawls upon said armature simultaneously with said ratchet to respectively push and pull it around and shift said pointer each time a circuit is made, in combination with a cam upon the pointer-shaft, a lever engaging with said cam, a cylinder provided with a series of train designating notices and a pawl connecting to said lever and engaging with a ratchet, all actuated by the rotation of the pointer-shaft to rotate said cylinder to change the notice which is displayed through a slot in the dial.

571,454. RAIL SUPPORT; W. B. Potter, Schenectady, N. Y. App. filed Aug. 25, 1896. As a new article of manufacture an insulator for a railway rail, comprising a body of insulating material, a metallic cap having a fixed lug and a removable lug, the two lugs adapted to engage with the flange on the rail, and means for securing the removable lug in place.

571,455. RAIL SUPPORT; W. B. Potter, Schenectady, N. Y. App. filed Aug. 25, 1896. An insulator for a railway rail, comprising a body of insulating material, a metallic cap secured to the insulator, the cap being provided with a fixed lug, and means for securing the rotatable lug in its engaging position.

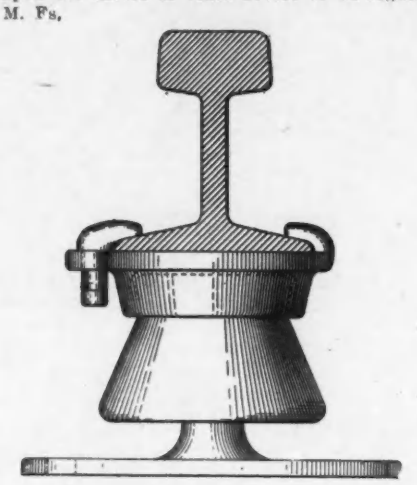
No. 571,420.—COMMUTATOR BRUSH.

571,460. PRIMARY BATTERY; S. N. Smith, Minneapolis, Minn. App. filed Nov. 16, 1895. The combination in an electric primary battery of the cell, with a porous cup of clay fastened in the bottom thereof, a cover tightly fitting the cell, a cylindrical zinc element suspended from said cover into the cell outside of said porous cup, a porous cup of carbon also suspended from said cover and extending into said cup of clay, a washer or packing provided between said cover and the top of said cup of clay, electrical connections on said cover with said zinc and carbon parts, said zinc and carbon parts being removable with said cover, a depolarizer comprising acidulated nitrate of soda provided in said carbon cup, and a solution of common salt provided in the cell outside said cup of clay.

571,462. FIELD MAGNET STRUCTURE; D. P. Thomson and H. Geisenhoner, Schenectady, N. Y. App. filed Aug 18, 1896. A field magnet structure for dynamo electric machines consisting of salient poles of laminated structure provided with separate laminated tips, and means for securing the tips to the poles.

571,463. CONTROLLING ELECTRIC ARCS; E. Thomson, Swampscott, Mass. App. filed June 26, 1896. An improvement in the art of controlling electric arcs, which consists in subjecting the arc to the directive influence of a resultant field of force produced by a plurality of magnetic or electromagnetic devices, the lines of force from some of which tend to drive the arc in one direction, while those from the other devices act to oppose or modify the action of the first named.

571,467. REGULATING POLYPHASE CIRCUITS; A. H. Armstrong, Schenectady, N. Y. App. filed May 2, 1896. The art of regulating a polyphase alternating current motor, translating device or other circuit, which consists in introducing between the circuit to be controlled and the main source of polyphase E. M. Fs. intermediate constant E. M. Fs. of the lines and those of the intermediate source from coincidence to opposition, thus impressing upon the motor or other device to be regulated the desired resultant E. M. Fs.



No. 571,454.—Rail Support.

571,472. TRACK INSTRUMENT; T. B. Dixon, Henderson, Ky. App. filed Nov. 15, 1895. In a track instrument, the combination with a magnet, of two armatures connected together, movably mounted and located in magnetic fields of said magnet, said armature occupying different relative positions with respect to the poles of their respective magnetic fields, and the field of one of said armatures being arranged to be weakened with respect to the field of the other armature when a train passes over the track, and means for holding the first named armature normally in closer proximity to the poles of its magnetic field than the other armature, whereby, when a train passes over the track, said armatures are caused to move.

571,478. ALTERNATING-CURRENT MOTOR; M. Hutin and M. Le Blanc, Paris, France. App. filed May 25, 1895. The combination with an electric circuit possessing self-induction charged with alternating currents, of an electrolytic polarization-battery having a sufficient number of cells in series to neutralize by polarization the E. M. F. of the self-induction in the circuit.

571,488. FOOT BELT; J. W. Madden, Brooklyn, N. Y. App. filed July 11, 1896. A foot belt comprising a flexible strip and a metallic plate punched and folded to engage the ends of the strip.

571,489. MANUFACTURE OF ELECTRICAL RESISTANCES; A. J. Marquand, Cardiff, and D. Lowdon, Barry Dock, England. App filed June 25, 1896. An electrical resistance composed of asbestos cloth, having deposited in its textures carbon resulting from the decomposition of carbonaceous material in contact with the asbestos cloth.

571,502. ELECTRICAL ELEVATOR; R. Wilson, Louisville, Ky. App filed July 8, 1895. In an electrical elevator, the combination of an electrical machine adapted to act either as a motor or as a dynamo, a controlling resistance for said machine when operating as a motor, a controlling resistance for the machine when operating as a dynamo, and an electromotive device actuating or controlling both of said resistances and means whereby said electromotive device may be operated at will from the car.

571,504. MICROPHONE TRANSMITTER; E. A. Barkalow and N. Crawford, Kokomo, Ind. App. filed July 31, 1896. In a microphone transmitter, the box, a vibratory diaphragm clamped over the front open side of the box and included in the primary circuit, a non-conducting cup secured within the box in rear of the diaphragm and open at its front side, a mass of granulated carbon or similar material entirely filling the cup and confined therein by the diaphragm, which is in direct contact with said material, and a carbon pencil or rod extending through the cup and having the portion within the cup entirely surrounded by the granulated material.

571,507. ELECTRIC SIGNALLING SYSTEM; J. P. Buchanan, Boston, Mass. App. filed Feb. 5, 1894. In an electric signalling system, the combination of an electric signal falling by gravity into "danger" position, an electromagnet arranged to operate said signal to put it to "safety," a battery having its poles permanently connected to the operating magnet, a shunt circuit around the battery containing a pair of contacts controlled by a track-circuit, said shunt-circuit operating when closed to permit the signal to go to "danger" by gravity and when open to put the signal to "safety" by the power of the magnet.

571,517. AUTOMATIC TROLLEY SWITCH; L. M. Erb, Leavenworth, Kan. App. filed Feb. 29, 1896. In a trolley switch, in combination, a shiftable tongue and a trigger lying in the path of the tread of the trolley wheel and adapted to be moved upward by the upward pressure of the trolley and thereby shift said tongue.

571,539. ELECTRICAL SWITCH CONDUCTOR; W. H. Sawyer, Providence, R. I. App. filed Aug. 12, 1896. An electrical cord or conductor composed of an elastic rubber core, surrounded by a braided web carrying one or more wires or conductors and the whole enclosed within a suitable or braided covering.

571,594. CABLE TERMINAL BOX; W. H. Johnston, St. Louis, Mo. App. filed Sept. 14, 1896. In a cable terminal box, the combination with a main cable head and an auxiliary cable head forming the box, said main and auxiliary cable heads being adapted to contain the main and office cables respectively, of binding screws or terminals located upon each cable head to which the conductors of the respective cables are adapted to be connected, and external conductors adapted to electrically connect the terminals connected with the conductors of one cable with the terminals connected with the conductors of the other cable.

571,598. MANUFACTURE OF PLATES FOR ELECTRIC ACCUMULATORS; J. Korner, Mannheim, Germany. App. filed Jan. 6, 1896. As an improvement in the manufacture of secondary-battery plates, causing a protective layer of sulphate of potash to be deposited thereon and then applying the active material or paste.

571,600. CONTROLLER FOR ELECTRIC PUMPS; F. W. Merritt, Duluth, Minn. App. filed Feb. 14, 1896. In a controller for electric pumps, the combination with a switch governing the electric circuit of the pump-motor, of a switch-actuating piston and cylinder, a controlling piston and cylinder connected at one end with the force side of the pump, a spring acting on said piston in opposition to the pump-pressure and an intermediate cylinder and piston controlling fluid pressure supply and waste of the switch-cylinder and piston, and in turn governed in operation by said controlling-piston.

571,669. LIGHTNING ARRESTER; A. De Khotinsky, Boston, Mass. App. filed Sept. 24, 1896. A spark or air gap protective appliance, consisting of two carbon plates having their proximate surfaces grooved or channeled, and a centrally-slotted non-conducting septum between them, the edges of the slot coinciding with the axial or central lines of the said channels.

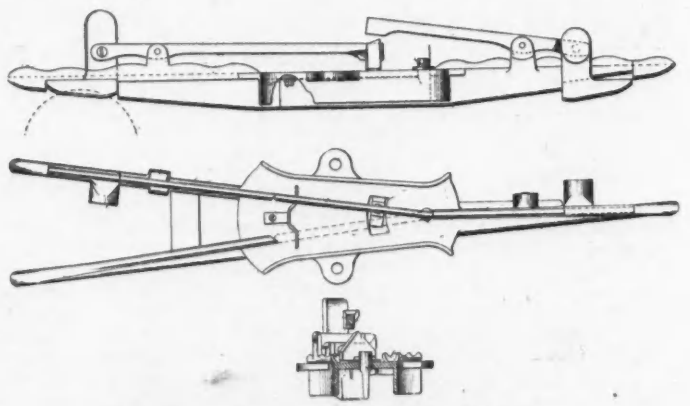
571,695. TELEGRAPH SWITCH MECHANISM; F. P. Scott, Terre Haute, Ind. App. filed March 25, 1896. In a telegraph switch mechanism, the combination with the switch arm and its shaft, of a motor so connected up with the shaft as to operate it, a battery, an armature, a contact point, a circuit through the motor, armature, contact point and battery, a branch line connected up with the magnet which operates the armature, and means in the branch line for operating said armature.

571,706. ELECTRIC CABLE; S. P. Thompson, London, England. App. filed July 20, 1892. In an electric cable having continuously insulated metallic conductors from end to end, the combination with the said conductors of a series of compensators or devices possessing both resistance and self-induction systematically distributed at intervals along the entire length of the cable, so proportioned and arranged that their electromagnetic induction shall counterbalance from point to point the effect of the distributed electrostatic capacity of the gutta-percha surrounding the said conductors.

571,707. ELECTRIC CABLE; S. P. Thompson, London, England. App. filed July 20, 1892. The method of counterbalancing the effect of distributed electrostatic capacity in long lines of metallic return-circuits in which the conductors are separately insulated throughout, which consists in dividing the circuit into a series of successive separately insulated metallic return circuit, in each of which a movement of electricity takes place, and connecting these circuits by mutual induction.

571,710. TROLLEY FOR ELECTRIC CARS; S. F. Tufts, Westbrook, Me. App. filed Oct. 9, 1895. In combination with a trolley for electric cars, a trolley-wheel mounted in a standard carried by a head, a spring for holding said standard in a raised position, arms on said standard, a disc working between said arms and carried and free to slide upon a rod secured in the head, and a spring on each side of said disc to hold it normally in a central position.

571,723. ELECTRIC GAS LIGHTING APPARATUS; C. W. De Mott, Brooklyn, N. Y. App. filed May 8, 1896. The combination in an electric gas lighting circuit, of an electromagnet, oscillating armature, contact-plates for the section-wires mounted loosely on the vibrating axis of the armature, and having the insulating strip for breaking the circuit through said section-wires, contact devices connecting said plate with the magnet-wire, and the rigid arm of the armature-shaft connected with the contact-plate by a slack-motion device whereby it is inoperative on said plate in the normal use of the lighting apparatus, but causes said plate to interrupt a short circuit.



No. 571,517.—Automatic Trolley Switch.

571,734. ELECTRIC CUT-OUT; B. F. Rout, Stanford, Ky. App. filed March 27, 1896. A circuit closer or cut-out device, a non-conducting base and upper and lower blocks, a sliding rod carrying a contact plate, the contact arms pivotally connected to the lower contact blocks, and means carried by the operating rod to move said contact arms into and out of contact with the upper contact blocks.